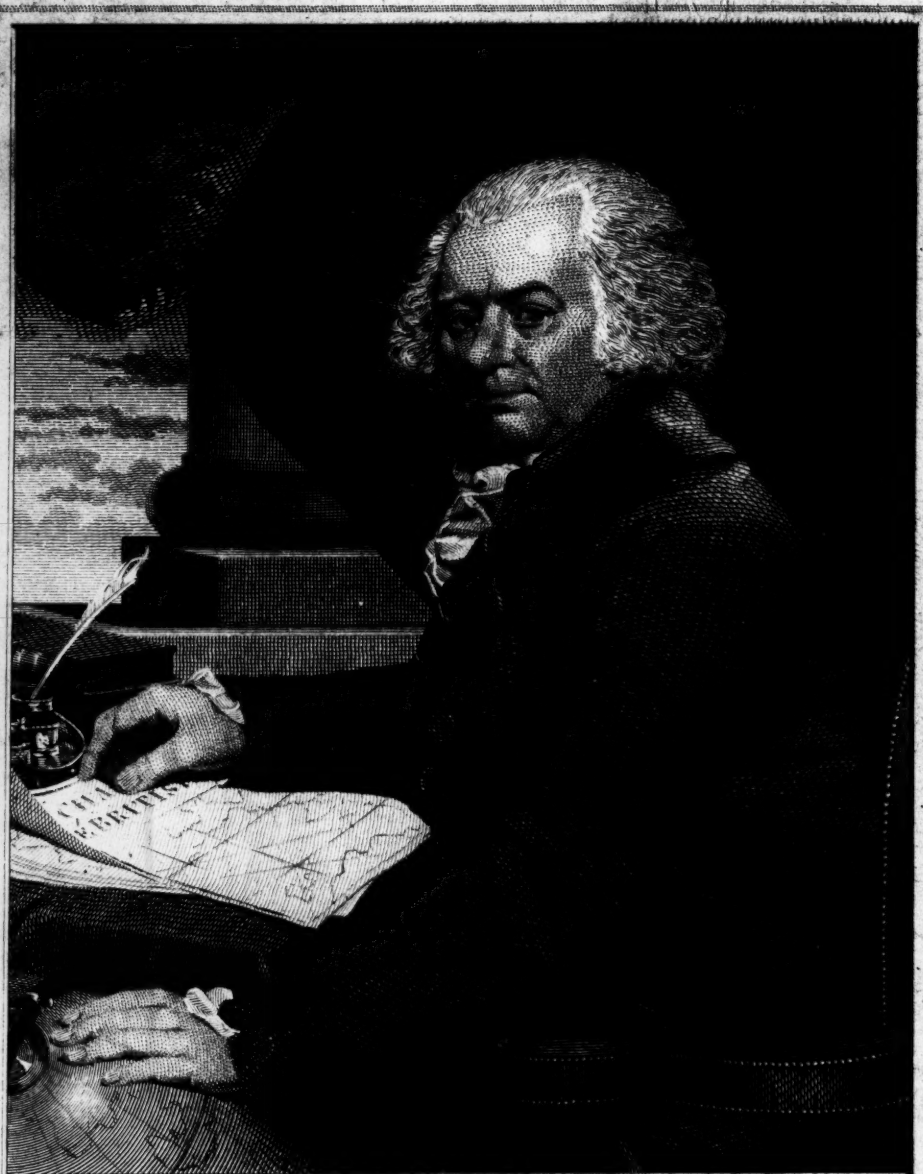




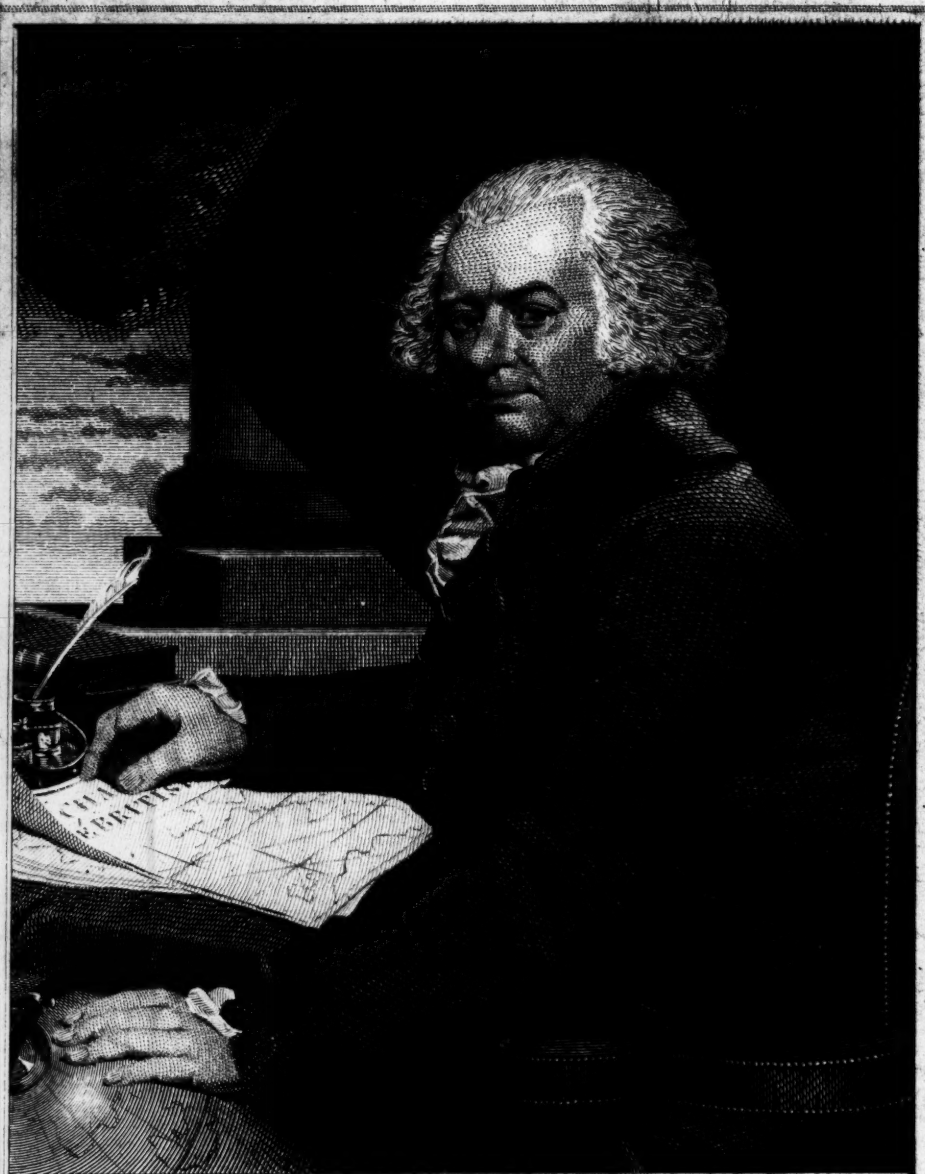
*Printed by R. Muller*

*Engraved by J. Baker*

**JOHN HAMILTON MOORE.**

London, Published as the Act directs, March 1<sup>st</sup> 1783, by W. HEATHER, N<sup>o</sup> 157, Leadenhall Street.





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*13 Ne*

# THE NEW PRACTICAL NAVIGATOR;

BEING AN  
EPITOME OF NAVIGATION,  
RENDERED EASY TO ANY COMMON CAPACITY:

CONTAINING ALL THE  
*REQUISITE TABLES*  
FOR DETERMINING THE  
LATITUDE AND LONGITUDE,  
AND  
KEEPING A COMPLETE RECKONING AT SEA:

ILLUSTRATED BY  
PROPER RULES AND EXAMPLES,

THE WHOLE EXEMPLIFIED IN A

JOURNAL

KEPT FROM

ENGLAND TO THE ISLAND OF TENERIFFE.

SO THAT THIS BOOK, AND THE NAUTICAL ALMANAC, WILL BE  
FOUND FULLY SUFFICIENT FOR THE SEAMAN AND TEACHER'S USE.

CONSTRUCTED ON A NEW PLAN.

---

BY JOHN HAMILTON MOORE, *R*  
TEACHER OF NAVIGATION, HYDROGRAPHER AND CHART-SELLER  
TO HIS ROYAL HIGHNESS THE DUKE OF CLARENCE.

---

L O N D O N:

PRINTED FOR AND SOLD BY THE AUTHOR, ON TOWER-HILL; ALSO SOLD BY  
WILLIAM HEATHER, AT THE NAVIGATION WAREHOUSE,  
157, LEADENHALL-STREET.

1793.

[ This Book is entered at Stationers Hall. ] *2*



TO THE HONOURABLE  
**COURT OF DIRECTORS**  
OF THE  
**UNITED COMPANY OF MERCHANTS**  
**TRADING TO THE EAST INDIES.**

GENTLEMEN,

**HAVING** through propensity of genius been devoted to mathematical pursuits from early life, and directed my studies for a course of thirty years to the improvement of nautical knowledge, a branch of science highly interesting to every commercial state, as essentially conducive to its welfare and happiness; I enjoy the pleasing reflection of being honoured repeatedly with the patronage and protection of the most respectable characters in the several maritime departments, and presume, from the favourable reception of no less than Nine Editions of my **PRACTICAL NAVIGATOR**, that I may be permitted, without the imputation of vanity, to consider such extraordinary encouragement as a substantial testimony of the general approbation of that part of the community, which justly claims an exclusive right to decide on their merits.

Perfection is not the lot of human nature, it is only the goal of emulation; competition stimulates to exertion, and the utmost attainment is the combined reward of fame and profit, which candour must acknowledge to be the most powerful incentives to human actions.

Impressed with these ideas I undertook this new Treatise, which I have the honour of presenting to the first Mercantile Body in the World; an association that has so widely extended commerce, so liberally encouraged manufactures, and so essentially promoted the useful arts, that a triple alliance which constitutes the basis of opulence and power, and renders these realms at once the wonder, the envy, and the terror of distant as well as surrounding empires.

I have only to add, that I feel an irresistible impulse to cherish the most sanguine hope that this new Treatise, as my last effort in the vale of years, will be attended with a favourable issue in reception, and thereby crown the labours of a life dedicated to an employ, which I trust, will be considered laudable in its principle, and beneficial in its effect. I have the honour to subscribe myself,

GENTLEMEN,

Your most devoted,

And very humble Servant,

**JOHN HAMILTON MOORE.**

LONDON, *July 12, 1793.*



---

## P R E F A C E.

---

**T**HE general design of this NEW PRACTICAL NAVIGATOR is, to comprise every thing essential to form the Teacher, instruct the Pupil, and assist the Mariner, so as to render them proficient in the Nautical Art, both with respect to theory and practice.

By recurring to former treatises, the productions of others; as well as my own (of which Nine Editions have passed through public favour) I presume that I have been enabled to make gradual improvements arising progressively, as my knowledge became extended through investigation, and my judgment matured by experience.

My grand object in this my New and last Treatise, has been to be concise yet comprehensive, explanatory in my Definitions, perspicuous in my Rules and Examples; and, in a word, most carefully attentive to every particular in theory and practice, that can further the grand design of the WORK, which is to facilitate the acquisition of an art that has been the object of my pursuits throughout life; and in which I have laboured with indefatigable assiduity.

To obtain this important purpose, I found it necessary to revise with the utmost care, circumspection, and caution, all the Treatises on Navigation now extant, to place them in a comparative view, and to discriminate their merits and defects, so as to adopt the former and reject the latter. Many of these works appeared too voluminous and elaborate, and the Tables necessary to the practical part of Navigation to be scattered throughout different books; hence, I conceived it might be both useful and acceptable, to bring these tables into one point of view by reducing them to a single volume, and numbering and arranging them in a more methodical manner than hitherto done, so that time would be saved in referring to them, and operations in the art greatly expedited thereby.

Upon a candid though circumspect review of the tables in the NEW PRACTICAL NAVIGATOR, I presume they will be found not only more extensive but more correct than have ever before appeared in a work of this kind.

To

To assist the Learner in that very essential branch of Navigation, the keeping a complete Reckoning at Sea, I have subjoined to this work a compendium of oblique-angled Trigonometry, with its application in oblique and current Sailing, and also Surveys of Coasts and Harbours, and other particulars necessary to be known by every Practitioner in the art.

Such is the PLAN of the WORK now offered to the public, which I hope will obtain a decided preference, as it comprises, in a small compass, every useful Discovery and Improvement made by Theoretical as well as Professional Men, through a long series of study, observation and practice; and the whole laid down in a manner as concise, plain, and intelligible, as the nature of the subject can possibly admit.

Upon the whole, I may venture to affirm, that this BOOK, with the NAUTICAL ALMANAC, will be found in every respect adequate to the purpose both of the Teacher and Scholar, as well as fully adapted to the use and advantage of the industrious Mariner, as in the forming of it, I have occasionally considered myself as acting in those three several capacities, and in conformity to the same, have respectively adapted my remarks, observations, and instructions; keeping in view throughout the whole, uniformity of method and facility of operation. From pursuing this plan, the expence of purchasing several books will be obviated, loss of time and many inconveniences will be prevented; and such advantages accrue to those immediately concerned in having recourse to it, as I trust will justify me in submitting it to the approbation of the public, and secure to me their sanction and encouragement, to merit which has been my highest ambition, and the ultimate view of my pursuits throughout life.

I am well aware that there are persons, who, to shew their own superior abilities in an obscure Club, will quibble and carp at some parts, and say, that they see nothing new, &c. To such Critics it may be answered, that a Triangle was a Triangle before the days of Euclid, and so it is now; but, if the arranging, digesting, simplifying, and rendering Navigation attainable to the most common capacity, with all the useful Tables contained in one Book, which was never done before, it certainly may be called New, or at least an Improvement.—How far I have succeeded is left to the judicious Mariner to determine.

*The Work may be more fully seen, by reading the following Contents.*

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CAUTION TO SEAMEN.

☞ The RAPID SALE my former Publications have had, has induced persons in Scotland, Ireland, and other places to copy them, many of which have been distributed in different parts of the world, particularly in the *East Indies* and *America*;—in order to prevent such *spurious* and *erroneous* Editions being imposed on the Public in future, a striking Likeness of the Author, drawn by MULLER, and engraved by BAKER, will be prefixed to each Book of this NEW WORK.

# GEOMETRICAL DEFINITIONS.

**G**EOMETRY is the Science which treats of the Description, Properties, and Relations of Magnitudes in general; of which there are three Kinds or Species, viz. a Line, which has only Length without either Breadth or Thickness; a Superficies, comprehended by Length and Breadth; and a Solid, which has Length, Breadth, and Thickness.

## I.

A Point considered mathematically, is incapable of being divided, and therefore hath no Parts, or it is the smallest Part of Space that can be assigned, and may be conceived so infinitely small, as to be void of Length, Breadth, or Thickness, being always denoted by a dot, as at A.

## II.

A Right Line is the nearest Distance between two Points which limits its Length, without A ————— C any supposed Breadth or Thickness, as A C.

## III.

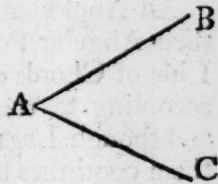
A Plane Superficies is that which lies evenly between its extreme Points, resembling a smooth Table, or polished Glass; bounded by Lines having Length and Breadth; but is conceived to have no Depth or Thickness.

## IV.

Parallel Lines are such as are equally distant in all their Parts, which extended infinitely on the same Plane would never meet, as the Lines A B, B C.

## V.

A Plane Angle is the Inclination or Meeting of two right Lines in one Point; the Point where they meet is called the Angular Point, and the Lines A B and A C are called Sides or Legs; it is generally expressed by three Letters, the Middle one always denotes the Angular Point, as A, and the other two the Legs or Sides that include it, as A B or A C.



A

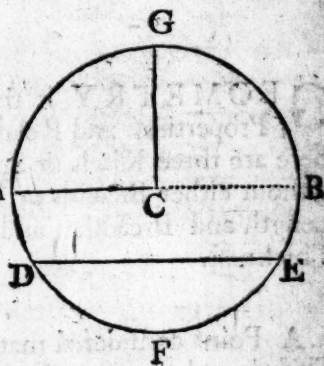
VI. A Circle

## VI.

A Circle is a plane Figure, bounded by an uniform curve Line, it is ordinarily described by a right Line, taken with a Pair of Compasses; one Point thereof, being fixed, whilst the other is turned round to the Place where the Motion first began; the fixed Point is called the Center, and the Line described by the other Point is called the Circumference.

## VII.

The Radius of a Circle or Semidiameter, is a right Line drawn from the Center to the Circumference, as AC; or it is that Line which is taken between the Points of the Compasses to describe the Circle; and is half its Diameter AB.



## VIII.

An Arch of a Circle is any Part or Portion of the Circumference, as DFE.

## IX.

A Chord of a Circle is the Substance of an Arch, or it is a right Line joining the Ends of an Arch; it divides the Circle into two unequal Parts, called Segments, and is a Chord to them both, as DE is the Chord of the Arches DFE and DGE.

## X.

A Semicircle, or Half a Circle, is a Figure contained under the Diameter, as AGB or AFB.

## XI.

A Quadrant is Half a Semicircle, or one-fourth Part of the whole Circle, as the Figure CAG.

NOTE. All Circles, whether great or small, are actually, or supposed to have their Circumference divided into 360 equal Parts, called Degrees, and each Degree into 60 equal Parts, called Minutes, and each Minute into 60 equal Parts, called Seconds, and so on into Thirds, Fourths, &c.

All Angles are measured by an Arch of a Circle, described round their Angular Points, with the Chord of 60 Degrees, taken from the Line of Chords on the Plane Scale, and are estimated greater or less according to the Number of Degrees contained betwixt their Legs; and though Legs be made longer or shorter, still the Angle between them continues the same,

A Right



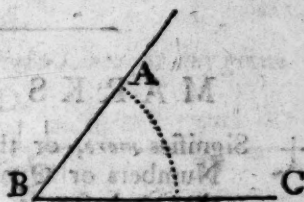
XII.

A right Line is said to be **PERPENDICULAR** to another right Line, when it falls upon it, so as to make the Angles on each Side of it equal, such as the Figure **ABCD**, where the Angle **ACD** is equal to the Angle **ACB**, each a Quadrant, or Right Angle, containing 90 Degrees.



XIII.

An **ACUTE ANGLE** is less than a Right Angle, and is that which contains less than 90 Degrees, as **ABC**.



XIV.

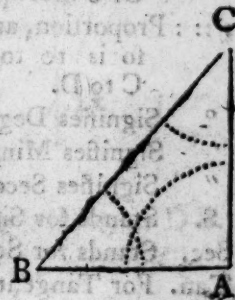
An **OBTUSE ANGLE** is greater than a Right Angle, and is that which contains more than 90 Degrees, as the Angle **GEH**.



The fewest number of right Lines that can include a Space are three, which form a Figure called a **Triangle**, or three-cornered Figure, and consists of Six Parts, viz. three Sides and three Angles: it is distinguished into three Sorts, viz. a **Right-angled Triangle**, an **Obtuse-angled Triangle**, and an **Acute-angled Triangle**.

XV.

A **RIGHT-ANGLED TRIANGLE** has one of its Angles right, or containing 90 Degrees; the Side opposite the Right Angle is called the **Hypothenufe**; and the other two Sides are called **Legs**; that which stands upright, is called the **Perpendicular**, and the other the **Base**; thus, **BC** is the Hypothenufe, **AC** the Perpendicular, and **AB** the Base: the Angles opposite the two Legs are both **Acute**.



XVI.

An **ACUTE-ANGLED TRIANGLE** has all its Angles acute, or none of them equal to 90 Degrees, as **DEG**.

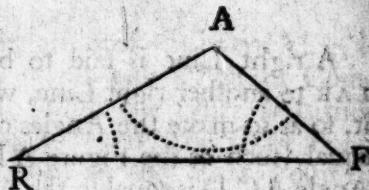


XVII. An

A 2

## XVII.

AN OBTUSE-ANGLED TRIANGLE has one of its Angles obtuse, or greater than 90 Degrees, as R A F, the other two Angles are Acute, or less than 90 Degrees, as in the Triangle R A F.



NOTE. All Triangles that are not right-angled, whether they are acute or obtuse, are in general Terms called oblique-angled Triangles, without any other Distinction.

## MARKS OR CHARACTERS.

- + Signifies *more*, or the Sign of Addition; it shews that whatever Numbers or Quantity follows this Sign must be added to those that go before it, thus  $9+8$ , that is, 9 added to 8. Or,  $A+B$  implies that the Quantities represented by A and B are added.
  - Signifies *less*, and is used as the Sign of Subtraction, it denotes that the Number following it must be subtracted from those going before it, as  $7-5$ , or 5 subtracted from 7.
  - $\times$  The Sign of Multiplication, and shews that the Numbers placed before and after are to be multiplied, thus  $7 \times 9$ , that is, 7 multiplied by 9, which makes 63, and  $7 \times 8 \times 2$  which makes 112.
  - $\div$  This Mark stands for Division, and signifies that the Number that stands before it is to be divided by the Number following it, as  $72 \div 12$  shews that 72 is to be divided by 12. Or thus,
 
$$\frac{72}{12}$$
  - = The Sign of Equality, it shews that the Numbers or Quantities placed before it are equal to those following it, thus,  $8 \times 12 = 96$ . Or 8 multiplied by 12 is equal to 96, and  $7+2 \times 4 = 36$ .
  - : :: Proportion, and is read thus,  $7 : 14 :: 10 : 20$  that is, as 7 is to 14 so is 10 to 20. Or,  $A : B :: C : D$  that is, as A is to B so is C to D.
  - ° Signifies Degrees, thus  $45^\circ$  shews the Number 45 Degrees.
  - ' Signifies Minutes, thus  $24'$  or 24 Minutes.
  - " Signifies Seconds, thus  $44''$  or 44 Seconds.
  - S. Stands for Sine.
  - Sec. Stands for Secant.
  - Tan. For Tangent.
- Each of these last with Co. before them, signify the Complement, as Co-sine, Co-tangent, Co-secant.
- < Signifies Angle.
  - <<sup>d</sup> Angled, with an s at top, Angles <<sup>d</sup>.
  - $\Delta$  Signifies Triangle, or  $\Delta^s$  Triangles.
  - Z Is frequently put to signify the Sum of any two Lines or Numbers.
  - X Signifies the Difference.

# GEOMETRICAL PROBLEMS,

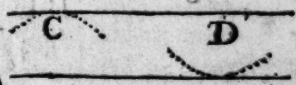
## USEFUL IN NAVIGATION.

*A Problem is a practical Proposition, in which something is proposed to be done or effected.*

### PROBLEM I.

*To draw a Right Line parallel to a given Right Line, at any given Distance, as the Point D.*

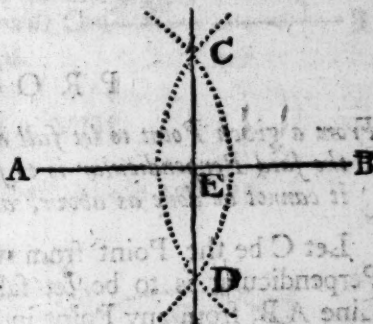
**WITH** a Pair of Compasses take the nearest Distance between the Point D and the given Right Line AB, with A that Distance set one Foot of the Compasses any where on the Line AB, as at A, and draw the Arch C, from the Point D draw a Line so as just to touch the Arch C, and it is done; for the Line CD will be parallel to the Line AB, and at the Distance of the Point given D, as was required.



### PROBLEM II.

*To bisect or divide a given Line in two equal Parts.*

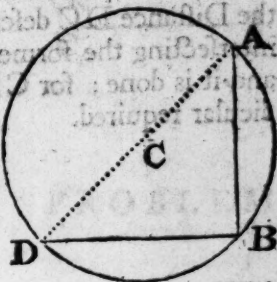
With any Distance in your Compasses greater than half the Line AB, with one Foot in B, describe an Arch with the same Distance, and one Foot in A, describe an Arch that will cut the former Arch in C and D; through C and D draw a Line, and that will cut AB in E; and the Line AB will be divided at the Point E into two equal Parts.



### PROBLEM III.

*To erect a Perpendicular on the End of a given Right Line, as DB.*

With any Distance in your Compasses, as from B to C, with one Foot in C, describe the Circle BDA, so that it may just touch the End of the given Line, at B: from where the Circle cuts the Line, as at D, draw a Line through the Point C, to cut the Circle in A, from A draw the Line AB, which will be the Perpendicular required.

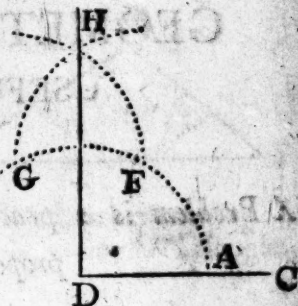


Or thus,

With



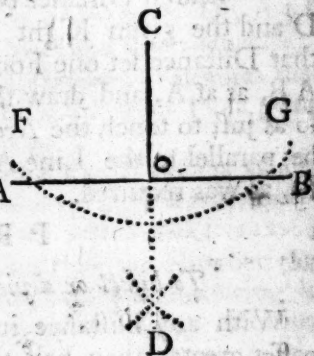
With any convenient Distance in your Compasses, as from D to A, with one Foot in D, describe the Arch AFG, set off the same Distance from A to F, and from F to G; upon F and G describe two Arches intersecting one another in H; draw a Line from H to D, and it is done; for HD will be the Perpendicular required.



#### PROBLEM IV.

*From a given Point, as C, to let fall a Perpendicular on a given Right Line AB.*

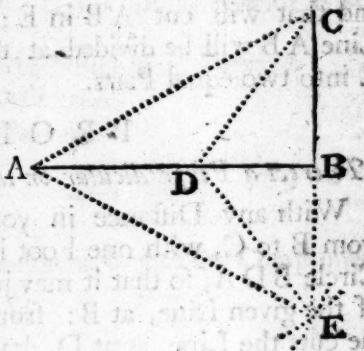
With one Foot in C, describe an Arch to cut the given Line AB in F and G, with one Foot in G describe an Arch, and with the same Distance, and one Foot in F, describe an Arch to cut the former in D, from C to D draw a Line, and it is done; for CD will be the Perpendicular required.



#### PROBLEM V.

*From a given Point to let fall a Perpendicular on a given Line, when the said Perpendicular is to fall so near the End of the given Line that it cannot be done as above, as at the Edge of a Sheet of Paper, &c.*

Let C be the Point from which the Perpendicular is to be let fall on the Line AB, from any Point in the Line AB, as at A; with the Distance AC, describe an Arch E, chuse any other Point in the Line AB, as D, and with the Distance DC describe another Arch intersecting the former in E, join CE, and it is done; for CB will be the Perpendicular required.

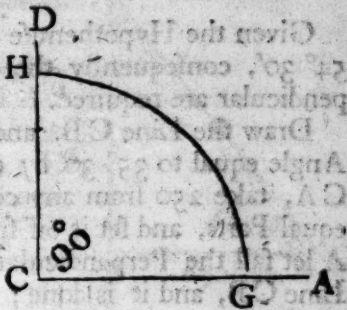


#### PROBLEM VI.

## PROBLEM VI.

*To make Plane Angles, and first a Right Angle, containing 90 Degrees.*

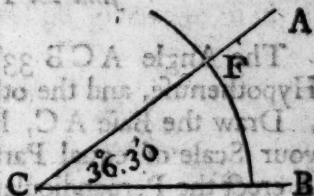
Draw the Line CA on C, erect a Perpendicular CD, and it is done; for the Angle DCA is an Angle of  $90^\circ$ . Or thus, On the Point C, with the Chord of  $60^\circ$ , describe an Arch GH, and set off thereon from G to H, the Distance of the Chord of  $90^\circ$ , and from C through H draw CHD, which will form the Angle DCA, of  $90^\circ$  required.



## PROBLEM VII.

*To make an Acute Angle equal to any Number of Degrees.  
Suppose  $36^\circ 30'$ .*

Draw the Line BC, with the Chord of  $60^\circ$  or Radius, in your Compasses, and one Foot on C, draw the Arch FB, on which set off  $36^\circ 30'$ , or  $36\frac{1}{2}$ , from B to F, through F and the Center C, draw the Right Line AC, and it is done; for the Angle ACB will be an Angle of  $36^\circ 30'$ , as was required.



## PROBLEM VIII.

*To make an Obtuse Angle, that shall contain  $127^\circ 20'$ .*

Draw CB, take the Chord of  $60^\circ$  in your Compasses, and with one Foot on C, describe an Arch; now as we can take off only  $90^\circ$ , set off  $90^\circ$  from B to G, and from G to E set off the Excess above  $90^\circ$ , which is  $37^\circ 20'$ , or  $37\frac{1}{3}$ ; draw the Line CE, and it is done; for the Angle ECB will be an Angle of  $127^\circ 20'$ .



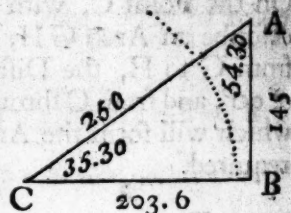
## PROBLEM

## PROBLEM IX.

*The Angles and Hypotenuse of a Right-angled Triangle given, to find either of the Legs.*

Given the Hypotenuse 250 Leagues, the Angle opposite the Base  $54^{\circ} 30'$ , consequently the other Angle  $35^{\circ} 30'$ ; the Base and Perpendicular are required.

Draw the Line CB, and at C make an Angle equal to  $35^{\circ} 30'$  by drawing the Line CA, take 250 from any convenient Scale of equal Parts, and set it off from C to A, from A let fall the Perpendicular AB, to cut the Line CB, and it is done; for AB measured on the same Scale, gives 145, and CB 203.6 Leagues.

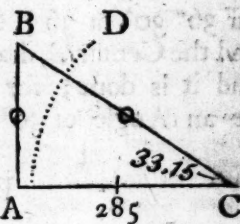


## PROBLEM X.

*The Angles and one Leg of a Right-angled Triangle being given, to find the Hypotenuse and the other Leg.*

The Angle ACB  $33^{\circ} 15'$ , the Leg AC 285 Miles, to find the Hypotenuse, and the other Leg AB.

Draw the Base AC, lay off on it 285 from your Scale of equal Parts, from A to C; on A erect the Perpendicular AB, with the Chord of  $60^{\circ}$  sweep the Arch AD, and on it set off  $33^{\circ} \frac{1}{4}$ , from your Line of Chords from A to D, through D and C, draw the Right Line BC, then BC will measure 341 nearly, and BA 187 nearly, on the same Scale of equal Parts that AC was taken from.

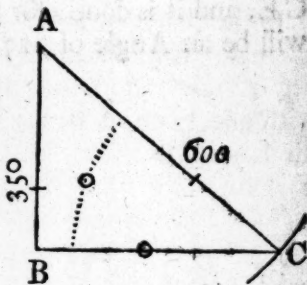


## PROBLEM XI.

*The Hypotenuse and one Leg given, to find the Angles and the other Leg.*

The Leg AB 350, the Hypotenuse 600 given, to find the Angles, and Leg BC.

Draw the Base CB, on B erect the Perpendicular AB, on which set off 350 from B to A, on the Point A with an Opening of 600. Draw an Arch to cut the line BC in the Point D, draw DA, and it is done; for the Angle ADB will measure  $35^{\circ} 41'$ . On the Line of Chords, and BD will measure 487 nearly on the same scale of equal Parts before used.



PROBLEM

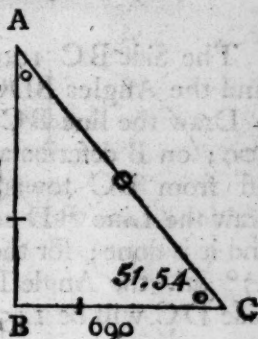


PROBLEM XII.

*The Legs given, to find the Angles and the Hypotenuse.*

The Leg AB 880 and BC 690 given, to find the Angles A and C, and the Hypotenuse AC.

Draw the Base BC, on B erect the Perpendicular AB, make BC equal to 690, and AB equal to 880; join AC, and it is done; for the Angle C being measured as before, will be found as per Figure, and the Hypotenuse will measure 1118,2.

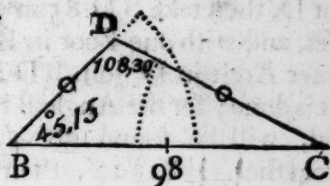


PROBLEM XIII.

*Two Angles and one Side, of an Oblique-angled Triangle given, to find either of the other Legs.*

The Angle BDC  $108^{\circ} 30'$ , and CBD  $45^{\circ} 15'$  and consequently the Angle BCD  $26^{\circ} 15'$ , and the Leg BC 98 given, to find the Sides CD and BD.

Draw the Line BC, which make equal to 98, on the Point B describe an Angle of  $45^{\circ} 15'$ , then add  $45^{\circ} 15'$  to  $108^{\circ} 30'$ , and the Sum  $153^{\circ} 45'$  taken from 180, the Remainder is the Angle DCB =  $26^{\circ} 15'$ ; from the Point C describe an Arch, with the chord of 60, and set off  $26^{\circ} 15'$ , and it is done; for the side DB will be 46 nearly, and DC 73,4, as was required.

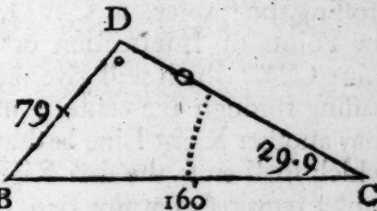


PROBLEM XIV.

*Two Sides and an Angle opposite to one of them given, to find the other Angle and the third Side.*

The side BC 160, and BD 79, and the Angle C  $29^{\circ} 9'$  given, to find the Angle D, and the Side CD.

Draw the Line BC equal to 160, on C make the Angle DCB equal to  $29^{\circ} 9'$ , take 79 in your Compasses, and with one Foot on B, lay the other upon the Line CD, draw the Line BD, and it is done; for the Angle D will be  $99^{\circ} 17'$ , the Angle B  $51^{\circ} 34'$ , and the Side DC 127 nearly.

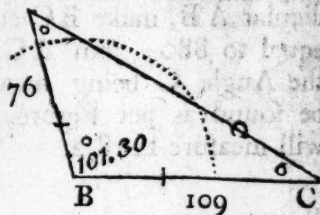


## PROBLEM XV.

*Two Sides and their contained Angle given, to find either of the other Angles, and the third Side.*

The Side BC 109 BD 76 and Angle CBD  $101^{\circ} 30'$  given, to find the Angles BDC or BCD and the Side CD.

Draw the line BC, which make equal to D 109; on B describe an Arch, on which set off from BC towards D  $101^{\circ} 30'$ , then draw the Line BD equal to 76, join DC, 76 and it is done; for the Angle BDC will be  $47^{\circ} 32'$ , the Angle BCD  $30^{\circ} 58'$ , and the Side DC will be 145, as was required.

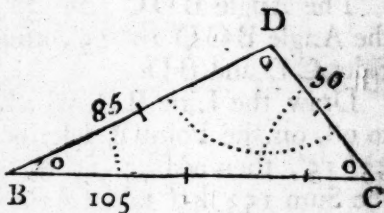


## PROBLEM XVI.

*Three Sides given, to find the Angles.*

The Sides BC 105, BD 85, and CD 50 Miles given, to find the Angles BDC, BCD, and CBD.

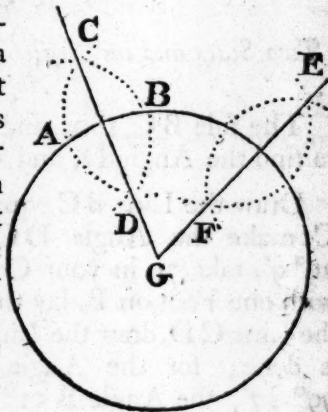
Draw the Line BC equal to 105, take CD equal to 50 in your Compasses, and with one Foot in C, describe an Arch as at D, then take BD 85 in your Compasses, and with one Foot in B, cut the former Arch in D, join BD and DC, and it is done; for the Angle B being measured, will be found  $28^{\circ} 4'$ , the Angle C  $53^{\circ} 8'$ , which being added together, is  $81^{\circ} 12'$ , their sum subtracted from  $180^{\circ}$  leaves Angle D  $98^{\circ} 48'$ , as was required.



## PROBLEM XVII.

*To find the Center to a given Circle.*

With any Radius, and one Foot in the Circumference as at A, describe an Arch of a Circle, as CBD, then removing the Foot from A to where it cuts the given circle, as at B, on B describe another Arch, cutting or crossing the former, as CAD, and through the Points of Intersection draw the Right Line CD, which will give one Right Line passing through the center; in like manner may another Right Line be drawn, as EFG, which shall cross the first Right Line at the center required, for any two Diameters will always cut or cross one another in the central Point.



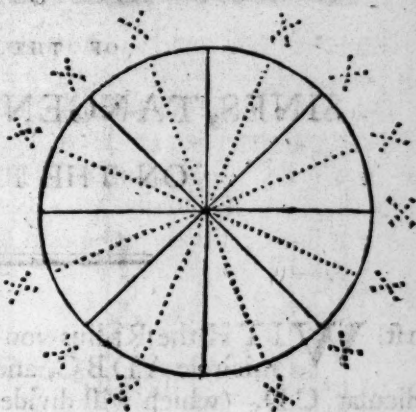
PROBLEM

PROBLEM XVIII.

*To divide a Circle into any Number of equal even Parts, as 4, 16, 32.*

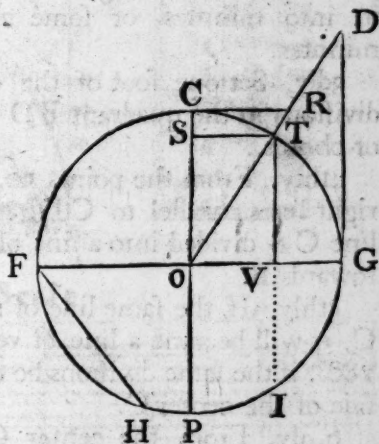
First draw the Diameter through the Center, which will divide it into two equal Parts, bisect the Diameter with another Right Line perpendicular thereto, and the Circle will be divided into four equal Parts or Quadrants; bisect each of these Quadrants again by Right Lines drawn through the Center, and it will be divided into eight equal Parts, and so may you continue on your Bisections any number of times, that is, 8, 16, 32, &c. doubling the Number of even Parts.

This Problem is useful in constructing the Mariner's Compass.



I. A Chord or Subtense of an Arch, is a Right Line that divides the Circle into two unequal Parts, and is a Chord to them both, as FH, TI.

II. A Right Sine of an Arch, is a Line drawn from the End or Termination of an Arch, perpendicular to the Radius, or is half the Chord of twice the Arch, so that TV is the Sine of the Arch, TG and of the Arch TF, the Sum of which Arches together make  $180^{\circ}$ , or a Semi-circle.



III. The versed Sine of an Arch, is that Part of the Diameter intercepted between the Right Sine and the Arch, as V G.

IV. The Tangent of an Arch, is a Line drawn perpendicular to the End of the Radius or Diameter, juſt touching the Arch, as DG.

V. The Secant of an Arch, is a Right Line drawn from the Center through the Circumference, meeting the End of the Tangent Line to the same Arch, as OD is the Secant of the Arch TG, to which TG is Tangent, also OR is the Secant of the Arch CR, to which CR is a Tangent.

NOTE. Sines, Tangents, Secants, are said to be of so many Degrees as the Arch contains Parts of 360, so that Radius being the Sine of a Quadrant, or a fourth Part of the Circumference, contains 90 Degrees, thus the Radius is always equal to the Sine of 90.



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# PROJECTION

OF THE LINES OF

## SINES, TANGENTS, AND SECANTS,

ON THE PLANE SCALE.

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1st. **W**ITH the Radius you intend for your Scale, describe a semicircle  $A D B C$ , and upon the center  $C$  raise the perpendicular  $C D$ , (which will divide the semicircle into two quadrants,  $A D$ ,  $B D$ ) continue  $C D$  directly to  $S$ , and upon  $B$  raise the perpendicular  $B T$ , then draw the right lines  $B D$  and  $A D$ .

2dly. Divide the quadrant  $B D$  into 9 equal parts, then will each of these be 10 degrees. Again, you may subdivide each of these parts into single degrees; and these again, if your radius admits it, into minutes, or some aliquot parts of a degree greater than minutes.

3dly. Set one foot of the compasses in  $B$  and transfer each of the divisions in the quadrant  $B D$  to the right line  $B D$ , then is  $B D$  a line of chords.

4thly. From the points 10, 20, 30, &c. in the quadrant  $B D$ , draw right lines parallel to  $C D$ , till they cut the radius  $C B$ , then is the line  $C B$  divided into a line of sines, which must be numbered from  $C$  towards  $B$ .

5thly. If the same line of right sines be numbered from  $B$  towards  $C$ , it will become a line of versed sines, which may be continued to  $180^\circ$ , if the same divisions be transferred on the same line on the other side of the center  $C$ .

6thly. From the center  $C$ , through the several divisions in the quadrant  $B D$ , draw right lines till they cut the tangent  $B T$ , so will the line  $B T$  become a line of tangents.

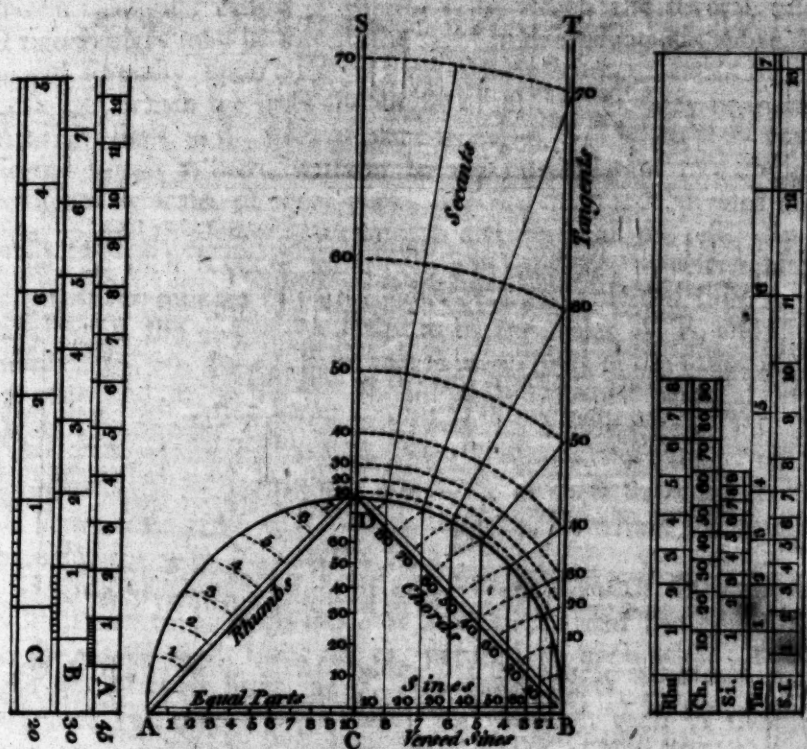
7thly. Setting one foot of the compasses in  $C$ , extend the other to the several divisions 10, 20, 30, &c. in the tangent line  $B T$ , and transfer these extents severally into the right line  $C S$ , then will the line  $C S$  be a line of secants.

8thly. Right lines drawn from  $A$  to the several divisions 10, 20, 30, &c. in the quadrant  $B D$ , will divide the radius  $C D$  into a line of semi-tangents.

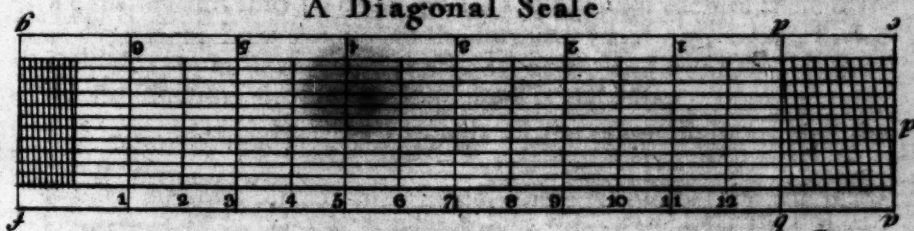
9thly. Divide the quadrant  $A D$  into eight equal parts, and from  $A$  transfer these divisions severally into the line  $A D$ , then is  $A D$  a line of rhumbs, each division answering to  $11^\circ 15'$  upon the line of chords.

The

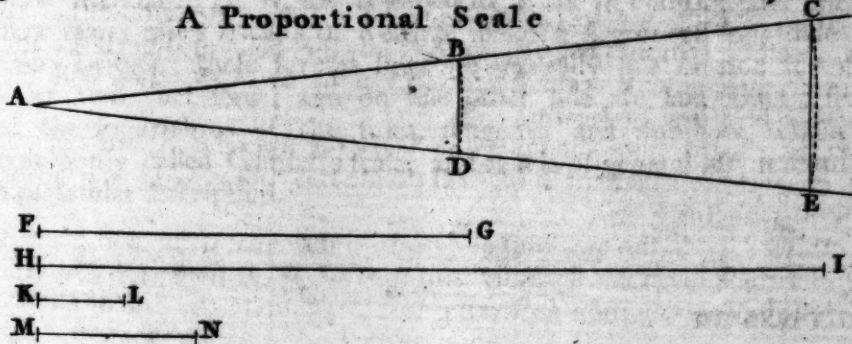
# **PROJECTION OF THE PLAIN SCALES, &c.**

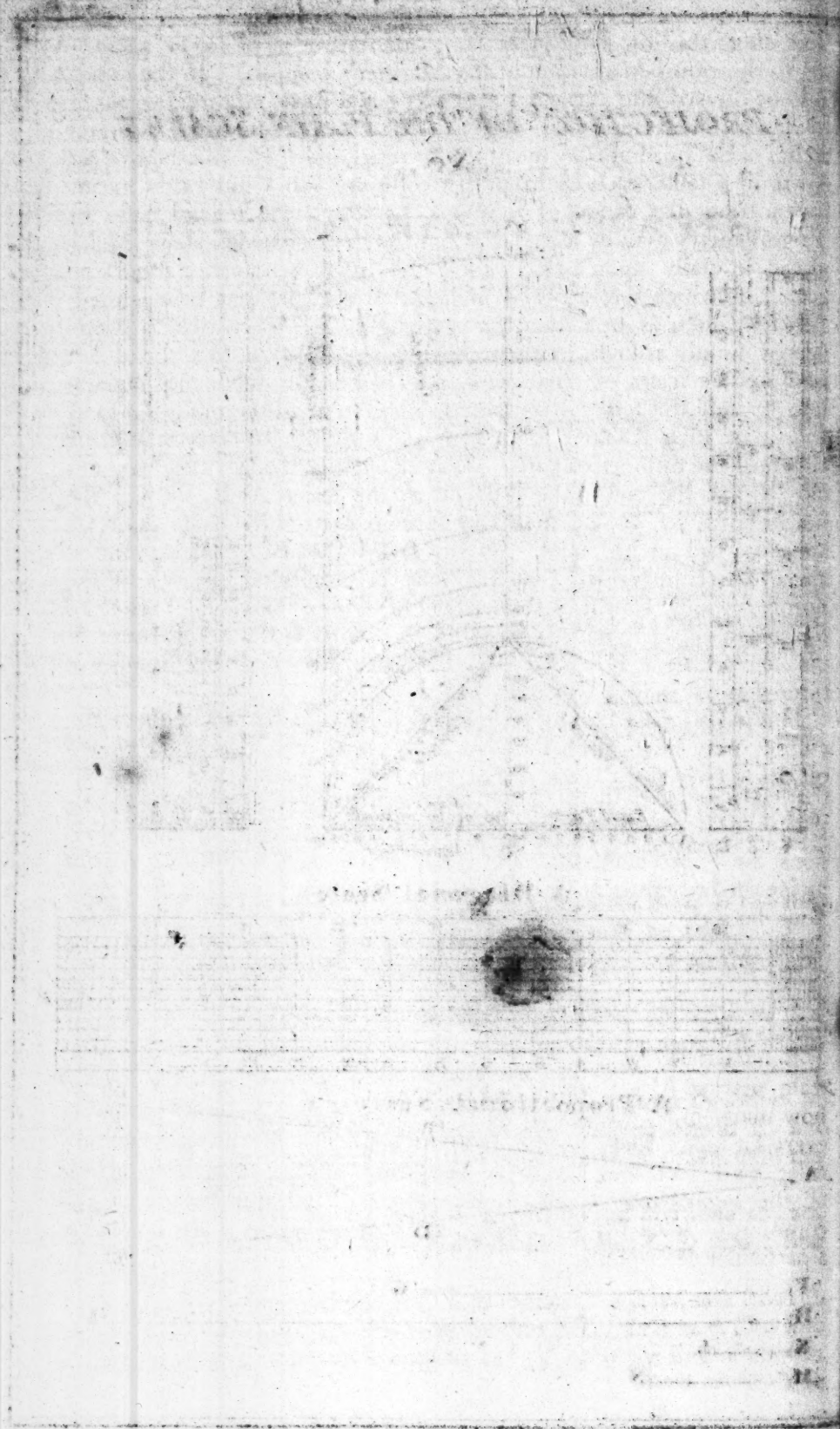


**A Diagonal Scale**



**A Proportional Scale**







The use of this line is for protracting and measuring of angles, according to the common division of the Mariner's compass. If the radius  $AC$  be divided into 100, or 1000, &c. equal parts, and the lengths of the several sines, tangents, and secants corresponding to the several arches of the quadrant be measured thereby, and these numbers be set down in a table, each in its proper column, you will by this means have a triangular canon of numbers, by which the several cases in Trigonometry may be solved, the right lines graduated as above, being placed severally upon a ruler, form the instrument called the Plane Scale; by which the lines and angles of all triangles may be measured. All right lines, as the sides of plane triangles, &c. when they are considered simply as such, without having any relation to a circle, are measured by scales of equal parts, one of which is subdivided equally into 10, and this serves as a common division to all the rest. In most scales, an inch is taken for a common measure, to determine their largeness and number of parts: what an inch is divided into, is generally set at the end of the scale, as in the scales  $A$ ,  $B$ , and  $C$ ; the numbers 10, 20, 30, 45, shew that so many parts of the scales  $A$ ,  $B$ ,  $C$ , are contained in an inch. By any scale of equal parts, divided as above, any number less than 100 may be readily taken; but if the number should consist of three places of figures, the value of the third figure can only be guessed at; wherefore in these scales it is better to use such a scale as  $D$ , called a diagonal scale, by which any number of three figures may be exactly found.

Having prepared a ruler of convenient breadth for your scale, (which may be an inch more or less) First, near the edges thereof, draw two right lines  $af$ ,  $cg$ , parallel to each other; then divide one of these lines, as  $af$ , into equal parts, according to the largeness you intend your scale; and through each of these divisions draw perpendicular right lines as far as the line  $cg$ ; next divide the breadth into 10 equal parts, and through each of these divisions draw right lines parallel to the former  $af$  and  $cg$ ; again, divide the length  $a$ ,  $b$ ,  $c$ ,  $d$ , each into 10 equal parts, and from the point  $d$  to the first division in the line  $dq$ , draw a right line; then, parallel to that line, draw right lines through all the other divisions, and the scale is done.

Besides the lines already mentioned, there is another on the plane scale marked  $ML$ , which is joined to a line of chords; and shews how many miles easting or westing make a degree of longitude in every latitude; these several lines are generally put on one side of a ruler two feet long; and on the other side are laid down a scale of the logarithms of the sines, tangents, and numbers, which is commonly called Gunter's scale, and as it is of general use, it requires a particular description.

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## DESCRIPTION AND USE OF GUNTER'S SCALE.

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**W**HILE the reader is perusing the following, it is proper he should have a GUNTER'S SCALE before him.

Gunter's Scale hath set upon it these eight Lines following :

1st. Sine rhumbs marked (SR) is a line which contains the logarithms of the natural sine of every point and quarter point of the Mariner's Compass, figured from the left hand towards the right, with 1, 2, 3, 4, 5, 6, 7, to 8, where is a brass pin, and where it can be done into halves and quarters.

2d. Tangent rhumbs marked (TR) also corresponds to the logarithm of the tangent of every degree of the said compass, and is figured 1, 2, 3, 4, at the center, where there is a pin, and from thence towards the left hand with 5, 6, 7, it is also divided, where it can be done, into halves and quarters.

3d. The line of numbers marked (Num.) contains the logarithms of the numbers, and is figured thus; near the left hand it begins at 1, and towards the right hand is 2, 3, 4, 5, 6, 7, 8, 9; and then 1 is the middle, at which is a brass center pin, going still on 2, 3, 4, 5, 6, 7, 8, 9, and 10 at the end, where there is another center pin; (as this line is generally much used, it requires a larger description). The first one may be counted for 1, or 10, or 100, or 1000, and then the next 2 is accordingly 2, or 20, or 200, or 2000, &c. Again, the first 1 may be reckoned 1 tenth, or 1 hundredth, or 1 thousandth part, &c. then the next is 2 tenth, or 2 hundredth, or 2 thousandth parts, &c. so that if the first 1 be esteemed 1, the middle one is then 10, and 2 to its right is 20, 3 is 30, 4 is 40, and 10 at the end is 100; again, if the first 1 is 10, the next 2 is 20, 3 is 30, so on, making the middle 1 now 100, the next 2 is 200, 3 is 300, 4 is 400, and 10 at the end is now 1000. In like manner if the first 1 be esteemed 1 tenth part, the next 2 is 2 tenth parts, and the middle 1 is 1, and the next 2 is 2, and 10 at the end is now 10. Again, if the first 1 be counted 1 hundredth part, the next is 2 hundredth parts, the middle one is now 10 hundredth parts or one tenth parts, and the next 2 is two tenth parts, and 10 at the end is now but one whole number or integer.

As the figures are increased or diminished in their value, so in like manner must all the intermediate strokes or subdivisions be increased or diminished; that is, if the first 1 at the left hand be counted 1, then 2 (on the right hand of it) is 2; and each subdivision between them

them now is 1 tenth part, and so all the way to the middle 1, which now is 10, the next 2 is 20, now the longer strokes between 1 and 2 are to be counted from 1 thus 11, 12, (where is a brass pin, then 13, 14, 15, sometimes a longer stroke than the rest, then 16, 17, 18, 19, 20, at the figure 2; and all the shorter strokes between them longer are now each to be counted for  $\frac{2}{10}$  parts, from the middle 1 to the next 2, now 20, from whence the longer strokes between the figures are units, thus, 21, 22, 23, &c. to 3 which now is 30, and the shorter strokes each between them, now is the tenth part of an integer; from 3, each short stroke, or division, is 1 tenth part of an unit. Again, if 1 at the left hand be 10, the figures between it and the middle 1 are common tens; and the subdivisions between each figure are units; from the middle 1 to 10 at the end; each figure is so many hundredths; and between these figures each longer division is 10; from the middle 1 to 2, each less division is 2 units; and from 2 to the end, each shorter division is 5 units. From this description it will be easy to find the divisions representing any given number thus: Suppose the point representing the number 12 was required? Take the division at the figure 1, in the middle for the first figure of 12; then for the second figure count 2 tenths, or longer strokes to the right hand, and this last is the point representing 12, where is the brass pin.

Again, Suppose the number 22 was required, the first figure being 2, I take the division to the figure 2, and for the 2d. figure 2, count 2 tenths onwards, and that is the point representing 22.

Again, Suppose 1728 was required for the first figure 1, I take the middle 1, for the second figure 7, count onwards as before, and that is 1700; then for the 3d. 2 count 2 tenths from the last, and it represents 1720; lastly, for the 4th, figure 8, estimate 8 parts out of 10 of the next small division, or a little less than 10, this point, last found, represents 1728.

Required the Point, representing the number 435; from the 4 in the 2d. interval count towards 5 on the right, three of the larger divisions, and one of the smaller, and that will be the division expressing 435, and the like of other numbers, which by a little practice is readily done.

All fractions found in this line must be decimals; and if they are not, they must be reduced into decimals, which is easily done by extending the compasses from the denominator to the numerator; that extent laid upon 1 in the middle will reach to the decimal required.

*Example.* Required the decimal fraction equal to  $\frac{3}{4}$ , extend from 4 to 3, that extent will reach from 1 on the middle to 75, towards the left hand; the like may be observed of any other vulgar fraction.

MULTIPLICATION is performed on this line, by extending from 1 to the multiplier; that extent will reach from the multiplicand to the product.

Suppose, for example, it was required to find the product of 16 multiplied by 4, extend from 1 to 4, that extent will reach from 16 to 64, the product required.

DIVISION



**DIVISION** being the reverse of Multiplication, therefore extend from the divisor to unity, that extent will reach from the dividend to the quotient.

Suppose 64 to be divided by 4, extend from 4 to 1, that extent will reach from 64 to 16, the quotient.

**N. B.** This extent in Division is to be taken backwards from the dividend to the quotient, but in Multiplication it is taken forward from the multiplicand to the product, they being contrary to one another.

**PROPORTION**, or the **RULE OF THREE**, being performed by Multiplication and Division, therefore extend from the first term to the second, that extent will reach from the third term to the fourth.

*Example.* If the diameter of a circle be 7 inches, and the circumference 22, what is the circumference of another circle the diameter of which is 14 inches?

Extend from 7 to 22, that extent will reach from 14 to 44, the same way.

In like manner may any other proportion of any denomination be worked, which makes this line of general use, particularly in measuring Superficies and Solids, which is done by extending from 1 to the breadth, that extent will reach from the length to the superficial content.

*Example.* Suppose a plank, or board 15 inches broad, and 27 feet long, the content of which is required.

Extend from 1 to 1 foot 3 inches; that extent will reach from 27 feet to 33,75 feet, the superficial content. Or extend from 12 inches to 15, &c.

The solid content of any bale, box, chest, &c. is found by extending from 1 to the breadth, that extent will reach from the depth to a fourth number, and the extent from 1 to that 4th. number, will reach from the length to the solid content.

*Example 1st.* What is the content of a square pillar, whose length is 21 feet 9 inches, and breadth 1 foot 3 inches?

The extent from 1 to 1,25, will reach from 1,25 to 1,56, the content of 1 foot in length; again, the extent from 1 to 1,56 will reach the length 21,75 to 33,8, the solid content in feet.

*Example 2d.* Suppose a square piece of timber 1.25 feet broad, from .56 deep, and 36 long, be given to find the content:

Extend from 1 to 1,25, that extent will reach from .56 to .7, then extend from 1 to .7, that extent will reach from 36 to 25,2 the solid content. In like manner may the contents of any bales, &c. be found, which divided by 40 will give the tonnage.

3dly. The line of Sines marked (Sin.) begins at the left hand, and is figured thus: 1, 2, 3, 4, 5, &c. to 10; then 20, 30, 40, &c. to 90, ending at the right hand, where a brass center pin, here, and in all lines under it, called degrees.

4thly. The line of versed sines, marked (V. S.) begins at the right hand, against 90° on the sines, and from thence figured towards the left hand thus: 10, 20, 30, 40, &c. ending at the left hand end about 169°;

169°; each of the subdivisions, from 10 to 30, are 2 degrees; and from thence to 90, it is single degrees, and from thence to the end, each degree is divided into 15 minutes.

5thly. The line of tangents, marked (Tan.) begins at the left hand as do the fines; from thence it is figured to the right hand, thus: 1, 2, 3, &c. to 10, and so on 20, 30, 40, and 45, at the right hand, where is a little brass pin, just under and even with 90° in the fines; from thence back again it is figured 50, 60, 70, 80, &c. to 89, ending at the left hand where it began at 1 degree. The subdivision of this line are the same as those of the fines.

6thly. The line of meridional parts, marked (Mer.) begins at the right hand, and is numbered thus: 10, 20, 30, to the left hand, where it ends at 87 degrees. This line, with the line of equal parts, marked (E P) under it, are used together, and only in Mercator's sailing. The uppermost line contains the degrees of the meridian, or latitude, in a Mercator's chart; and the lower is the equator, and contains the degrees of longitude.

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## ON THE

## USE OF THE SECTOR.

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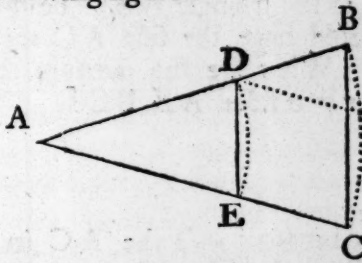
*The Use of the Line of Lines, marked on the same Side of the Sector (L L.)*

THE use of the sector is taken from the property of two equilateral similar triangles, thus in the following figure:

AB and AC are equal legs, or radii, of an isocles triangle, standing on the base BC: Now, by the property of similar  $\triangle$ s. drawing DE parallel to BC, the two triangles ADE and ABC are similar and proportional; or  $AD:DE::AB:BC$ .

$$AB:BC::AD:DE.$$

Now, supposing AB to be divided into 100 equal, the two equal lines AB and AC, and it is required to divide any opening of the legs, as BC in the same ratio as AB, AC is divided into, it is instantly performed by taking laterally the distance DE in your compasses, and apply it from C to B, and the line BC will be divided in the same ratio as is the line AB or AC.



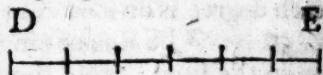
C

PRO-

## P R O B L E M I.

*To divide a given Line in any Number of equal Parts.*

Suppose DE is required to be divided into  
6 equal parts ?



OPERATION.—Take DE in your compasses, and open the legs of the sector, so that the opening of the compasses DE shall just fall on the line of lines on each leg of the sector, on 6.6 ; then take off 1.1 laterally, and set it from D to D 1, and D 1 will be the 1-sixth part of the given line DE.

To this problem may be referred the method of making a scale of a given length, to contain a given number of equal parts.

## P R O B L E M II.

Suppose the scale to the map of a survey is 6 inches long, and contains 140 poles required to open the sector, so that a corresponding scale may be taken from the line of lines ?

SOLUTION.—Make the transverse distance 7 and 7, or 70.70, viz.  $\frac{140}{2}$  equal to 3 inches =  $\frac{6}{2}$  ; and this position of the lines will produce the given scale.

## P R O B L E M III.

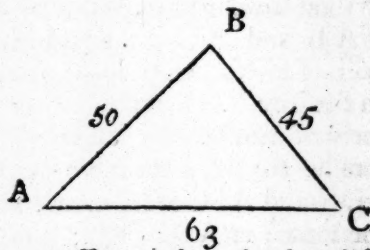
Let a scale of 4 inches to a degree in longitude be reduced to another scale of 3 inches to a degree of longitude ?

SOLUTION.—Set off any distance on the 4-inch scale transversely to 40.40 or 4.4, on the line of lines ; with this opening take off 3.3 or 30.30, and it is done, this lateral distance being the proportional part required.

## P R O B L E M IV.

One side of any triangle being given, of any length, to measure the other two sides on the same scale ?

Let the triangle ABC be drawn.  
I would have the side AC measure 63. What are the measure of the other two sides, AB BC ?



SOLUTION.—Take AC in your compasses, and apply that distance transversely to 6.3 or 63 ; to this opening of the sector apply the distance AB in your compasses to the same number on both sides of the rule transversely ; and where the two points fall will be the measure on the line of lines of the distance required ; the distance AB will fall against 50.50, and BC against 45.45 on the lines LL on each side.



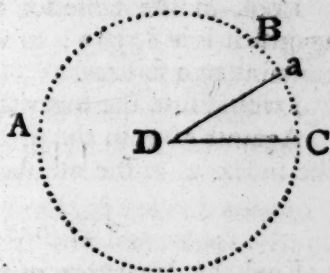
*Use of the Line of Chords on the Sector, marked (CC) on each Side;*

The line of chords on the sector is laid down on both sides as far as  $60^\circ$ ; each degree is divided in half or  $30'$ ; the use is only to lay down angles, or measure their arches to any given radius.

EXAMPLE I.

In the given circle ABC to lay off from the points C an  $\angle$  of  $30^\circ$ .  
B

SOLUTION.—Take the radius DC in your compasses, and open the sector until 60.60 on both sides fall on each point; with this opening take off 30.30 on both sides transversely, and apply it from C on the arch towards B, as at a, and it is done; and the  $\angle$  aDC is an arch of  $30^\circ$  required.



In this manner, by setting 60.60 to radius on the chords, or 90.90 on the sines, or  $45^\circ 45'$  on the tangents, may the chord, sine, or tangent, of any angle, be found, set off, or known, to any given radius.

LOGARITHMS.

LOGARITHMS are a series of numbers, invented by Lord Napier, Baron of Marchinston, in Scotland, by which the work of multiplication may be performed by addition, and the operation of division may be done by subtraction; so that great time and trouble are saved thereby in the performance of all arithmetical operations; for if the logarithm of any two numbers be added together, the sum will be the logarithm of the product; and if from the logarithm of the dividend you subtract their logarithm of the divisor, the remainder will be the logarithm of the quotient. Again, if the logarithm of any number be divided by 2, the quotient will be the logarithm of the square root of that number; or if the logarithm of any number be divided by 3, the quotient will be the logarithm of the cube root of that number.

The most convenient series now made use of is the following :

0    1    2    3    4    5    &c. logarithms.

1    10    100    1000    10000    100000, &c. numbers.

By which you perceive the index of any logarithm always one less than the number of figures the integer contains.

*To find the Logarithm of any Number containing less than 5 Figures.*

### EXAMPLES.

I would find the logarithm of 7?

Look in the table for the number of 7 in the side columns, and against it is 0.84510. This number having but one figure, the index thereto is 0.

I would find the logarithm of 79?

Look in the table for the logarithm 79 in the side column, and against it is 1.89763; to which 1 is the index, because the number contains two figures.

I would find the logarithm of 763?

Against 763, in the first side column, is 2.88252; to which prefix the index 2, as the number contains 3 places of figures, 2,88252.

*To find the Logarithm of 7634.*

Find the logarithm of the three first figures in side columns as before; and, casting your eye on the numbers on the top line of the table, look for the remaining figure 4, bring your eye to bear down that column, and right against 763 is the logarithm 88275, to which prefer the index 3, as it contains four places of figures, thus: 3.88275 is the logarithm of 7634.

*To find the Logarithm of any whole Number to 5 Places of Figures.*

Suppose 76345?

Look out the logarithm of the three first figures 763 in the side column, and the next figure 4 in the top column as before, and against the angle of meeting is 88275 as before. Take the difference between this logarithm and the next greater; that is, the difference between 275 and 332, which is 57; then say, by the rule of three, if 10 gives 57, what will 5 give? that is its half or 28; which, to be added to the logarithm 88275, makes 88303; to which prefix the index 4, as it contains five places of figures; and that makes the logarithm of 76845 to be 4.88303.

*Again, to find the Logarithm of any Number to 6 Places of Figures, as 763458.*

Find the logarithm of the 4 first places of figures as before 88275; as above then say, if 100 gives 57 difference, what will 58 give? Answer, 33; which added to 88275, makes 88308; to which prefix its index 5, makes the logarithm of 763458 to be 5.88308 nearly.

*To find the Logarithm of any mixed Number, as 763.458.*

Where the integer is 763, or has only three places of figures, the rule is : Find the logarithm to all the figures, the same as if they were whole numbers as before, to which prefix always the index of the integer, which in this number is 2 ; so that the log. of 763.458 is 2.88308, nearly the same as the above, only differing in its index.

*To find the Number answering to any Logarithm to 4 Places of Figures.*

Seek under the column 0, at the top of the table, the next less logarithm ; note the number against it, and carry your eye along that line until you find the nearest logarithm next less than the given one, and you will have the fourth figure at the top of the table, which affix to the three given ones in the first side column.

What is the number to the logarithm 3.77342?---I look in column 0, and find under it, against the number 593, the logarithm 7705 ; and, guiding my eye along that line, I find the given logarithm 77342 under the column, with 5 at the top ; so that the number is 5935.

*The number, if taken out by this precept, will be either the number required or the next less.*

*To find the Number answering any Logarithm to 5 Places of Figures nearly.*

Find the next less logarithm to the given one, and take its difference betwixt it and the given one ; also take the difference betwixt the next greater logarithm, and next less to the given one ; then say, as the difference of the next greater and next less is to 10, so is the former difference to the correction sought ;—as suppose you would find the number to the logarithm 4.59632 ?

4.59632

4.59626 The nearest next log. I can find is 59626 = its num. 39470

The next greater ditto is - 59637 = 39480

6 - - Difference - 11 10

Then say, 11 : 10 :: 6 : 5 nearly the correction ; which I add to the number 3947, makes the number sought to be 39475, answering to the logarithm 4.59632.

NOTE.—Aliquot or even parts may be taken of the difference between the less and greater logarithms, where it can be done, thus : In this last 6 is nearly the half of 11, as 5 the number sought is of 10, the difference of the two numbers belonging to the greater and less logarithms, which will often save time and trouble.



## MULTIPLICATION BY LOGARITHMS.

## CASE I.

*To find the Product of two whole or mixed Numbers.*

|          |      |                |          |       |                |
|----------|------|----------------|----------|-------|----------------|
| Multiply | 76   | Log. = 1.88081 | Multiply | 76.4  | Log. = 1.88081 |
| by       | 54   | 1.73239        | by       | 5.4   | 0.73239        |
| Product  | 4104 | = 3.61320      | Product  | 410.4 | = 2.61320      |

## CASE II.

When both, or either, of the fractions are less than unity, as if  
 $0.265$  Log.  $9.42325$  Here the index of a fraction is 9, when  
 $0.031$   $8.49136$  the first decimal figure, as 2, stands in  
the first decimal place; but if it should  
 $.008215$  =  $7.91461$  stand in the second decimal place, as the  
3 in  $.031$ , the index will be 8; if it stood in the third decimal  
place, as  $.0031$ , the index would be 7. Thus the number of cyphers  
prefixed to any decimal, and the index of that decimal always together,  
make 9; so that if you take the number of cyphers prefixed to the de-  
cimal from, 9 remains its proper index. In the addition reject 10 in  
the sum of the indices; and the proper product, or value of the pro-  
duct, will be obtained: By reason, if 9 represent the index of a frac-  
tion, 10 will represent, in this case, the index of unity. Indeed the  
index of unity may be assumed either 0, 10, 100, &c. as you please;  
but generally, for most uses, is not wanted to be more than 10, as in  
the sines, tangents, secants, &c. As 7 or 8 places of decimals are gene-  
rally sufficient for all purposes, take these two more examples:

|          |          |                |          |         |                |
|----------|----------|----------------|----------|---------|----------------|
| Multiply | 3.72     | Log. = 0.57054 | Multiply | 59.4    | Log. = 1.77415 |
| by       | 0.00064  | 6.86618        | by       | .000031 | 5.49206        |
| Product  | .0023808 | 7.37672        | Product  | 0018414 | 7.26621        |

Here the remainder to 9 is 2 in the index; therefore prefix two cyphers to the number of the logarithm 37672 for the product required.

## DIVISION OF LOGARITHMS.

## CASE I.

*To divide a whole or mixed number by a less whole or mixed Number.*

RULE.—From the logarithm of the dividend subtract the logarithm of the divisor, and the remainder is the logarithm of the quotient.

|        |                          |        |                          |
|--------|--------------------------|--------|--------------------------|
| Divide | 4104 by 54.              | Divide | 420.4 by 5.4.            |
| 4104   | Its logarithm is 3.61321 | 410.4  | Its logarithm is 2.61320 |
| 54     | Its logarithm is 1.73239 | 5.4    | Its logarithm is 0.73239 |
| 76     | Quotient = 1.88082       | 76.0   | Quotient = 1.88081       |

CASE

CASE II.

When both, or either, fractions are less than unity?

As divide .008215 by .031.

|         |             |         |
|---------|-------------|---------|
| .008215 | Its log. is | 7.91461 |
| .031    | Its log. is | 8.49136 |
| <hr/>   |             |         |
| .265    | Product     | 9.42325 |

NOTE.—In the indices here I borrow 10 in the same manner as I flung it away in addition.

Divide .0023808 by 3.72.

|          |             |         |
|----------|-------------|---------|
| .0023808 | Its log. is | 7.37672 |
| 3.72     | Its log. is | 0.57054 |
| <hr/>    |             |         |
| .00064   | Quotient    | 6.80618 |

NOTE.—Whatever index you make represent unity, omit it in the sum of the indices, and borrow it in the subtraction of indices, the sum or remainder will be the true index required.

NOTE.—If I had assumed the index of unity 100, then the index of the first number would have been 97 or 97.91461, and .031 98.49136

99.42325

So that 99 is the index of the first decimal place under 100 in this case.

Divide 59.4 by .00031.

|          |              |         |
|----------|--------------|---------|
| 59.4     | Its log. is  | 1.77415 |
| .00031   | Its log. is  | 5.49209 |
| <hr/>    |              |         |
| .0001915 | Its quotient | 6.28209 |

To EXTRACT the ROOTS in LOGARITHMS.

As the multiplying the logarithm of any number by the index of its power produces the logarithm of that power; so the division of any logarithm by its proposed index, the quotient will be the logarithm of the root required.

What is the square root of 324?

|     |                     |           |
|-----|---------------------|-----------|
| 324 | Its logarithm is    | 2)2.51054 |
| 18  | Log. of the root is | 1.25527   |

What is the cube root of 10648?

|       |                     |             |
|-------|---------------------|-------------|
| 10648 | Its log. is         | — 3)4.02726 |
| 22    | Log. of the root is | 1.34242     |

To find any proposed root of any decimal fraction, you must first prepare the index for the division by the proposed power, thus: For the square you must add 10 to the index before you divide it; for the cube you must add 20 to its index before you divide; and so on for the root of any power proposed.

EXAMPLE.—What is the square root of .001849?

|         |                         |            |
|---------|-------------------------|------------|
| .001849 | Its log. is             | 7.26694    |
|         | Add                     | 10.        |
| <hr/>   |                         |            |
|         |                         | 2)17.26694 |
| 43      | The log. of the root is | = 8.63347  |

What is the cube root of .125?

|       |             |            |
|-------|-------------|------------|
| .125  | The log. is | 9.09691    |
|       | Add         | 20.        |
| <hr/> |             |            |
|       | Sum         | 3)29.09691 |
| .5    | Its root    | = 9.69897  |

The

## The APPLICATION of LOGARITHMS in measuring Boards, Timber, Glaſs, Stone, and all kinds of Packages, uſually taken on board Ships \*.

Required the content of a board or plank  $9\frac{1}{2}$  feet long and  $1\frac{1}{4}$  foot broad ?

Log. of  $9\frac{1}{2}$  or 9.5 is 0.97772  
 $1\frac{1}{4}$  or 1.25 is 0.09691

11.88 nearly log. of cont. 1.07463,  
 or 11 feet  $10\frac{1}{2}$  inches nearly.

Required the content of a piece of glaſs 2.9 feet long and 1.75 broad ?

Log. of 2.9 = 0.46240  
 1.75 = 0.24304

5.075 = 0.70544  
 The content is 5.075 feet.

In like manner may any dimensions be ſquared, and the contents be found.

If the ſolid content be required of any box, bale, &c. add the logarithms of the length, breadth, and depth together, the ſum will be the log. of the ſolid content.

EXAMPLE.—What is the ſolid content of a box whoſe depth is 2.7, breadth 2.3, and length 4.5 feet?

2.7 Its log. is 0.43136  
 2.3 Its log. is 0.36173  
 4.5 Its log. is 0.65321

Sum equal the log. of the content 1.44630 = number 27.95 or 28 feet nearly.

The diameter of a caſk at the head and bung, and alſo its length being given, to find its content in beer and wine meaſure ?

1<sup>st</sup>. Multiply the difference of the head and bung diameter by 0.7, and add the product to the head diameter for a mean diameter.

### Rule for Wine Meaſure.

Place down the log. of the mean diameter twice the log. of the length, and under theſe two the conſtant log. 7.53148, the ſum of theſe four logarithms will be the log. of the content, abating 10 in the ſum of the indices.

### Rule for Beer Meaſure.

Put this conſtant log. under the two former logs. always 7.44484, the ſum of the four logs. will be the content for beer gallons, abating 10 in the index.

\* The Author has lately published an improved Gunter's Scale, on which the foot is divided into 10 equal parts, and theſe parts ſubdivided into 10 equal parts, for the purpoſe of taking dimensions and calculating by logarithms or decimal fractions.



EXAMPLE.—What is the content of a cask whose head diameter is 20, the bung diameter 28, and length 40 inches?

$$\begin{array}{r}
 28 \\
 20 \\
 \hline
 8 \text{ Difference.} \\
 .7 \\
 \hline
 5.6 \text{ Number to be added to,} \\
 \text{The head diameter } 20.0 \\
 \hline
 25.6
 \end{array}$$

| For wine.             |                                                                    | For beer.       |                                                                    |
|-----------------------|--------------------------------------------------------------------|-----------------|--------------------------------------------------------------------|
| Log. of mean diam. =  | $\left\{ \begin{array}{l} 1.40824 \\ 1.40824 \end{array} \right\}$ |                 | $\left\{ \begin{array}{l} 1.40824 \\ 1.40824 \end{array} \right\}$ |
| Length 40 =           | 1.60206                                                            |                 | 1.60206                                                            |
| Constant log.         | 7.53148                                                            |                 | 7.44484                                                            |
| <hr/>                 |                                                                    | <hr/>           |                                                                    |
| Log. of 89.13 gallons | 1.95002                                                            | Ans. 73 gall. = | 1.86338 of beer.                                                   |

the content for wine.  
The way these two constant multiplying logarithms were found is thus:

1st. The area of a circle, whose diameter is unity, is 7854 decimal parts of the square thereof; so that if the square of the diameter of any circle be multiplied by ,7854, the product will be the area of the given circle: hence ,7854 is always a constant quantity whose logarithm is 9,89509.

2d. If the area of a circle be divided by 231, the number of cubic inches there are in a wine gallon, the quotient will be the number of gallons that circular area contains, at 1 inch deep: hence 231 is a constant divisor. Its logarithm is 2.36361, the arithmetical complement of which is 7.63639, which I add to the former constant logarithm

$$\begin{array}{r}
 9.89509 \\
 7.63639 \\
 \hline
 \end{array}$$

The sum 7.53148, abating 10 in the indices, is the constant logarithm to be added, as per rule, for wine measure.

For beer measure the divisor is always 282, its logarithm is 2.45025, whose arithmetical complement is 7.54975

$$\begin{array}{r}
 7.54975 \\
 \text{Add } 9.89509 \\
 \hline
 \end{array}$$

Sum 7.44484, the constant logarithm for beer measure, as per rule, omitting 10 in the index, or subtract 2.45025 from 9.89509

$$\begin{array}{r}
 9.89509 \\
 \text{Take } 2.45025 \\
 \hline
 \end{array}$$

Remains 7.44484, the same as above.

D

The

*The common Way of finding a Ship's Tonnage at London.*

**RULE.**—Multiply the length of the keel by the breadth of the beam, and that product by half the breadth of the beam, and divide the last product by 94, and the quotient arising is the tonnage.

**EXAMPLE.**—Suppose a ship 72 feet by the keel, and 24 feet by the beam, what is the tonnage?

|                                  |     |   |         |                 |
|----------------------------------|-----|---|---------|-----------------|
| Length                           | 72, | - | log. is | 1.85733         |
| Breadth                          | 24, | - | do.     | 1.38021         |
| Half-breadth                     | 12, | - | do.     | 1.07918         |
| Arith. complement of log. of 94, |     |   | do.     | 8.02687         |
| Tonnage 220.6                    |     |   |         | 2.34359 Answer. |

*To find the Logarithm of the Sines, Tangents, and Secants, belonging to any Number of Degrees and Minutes required.*

If the required degrees be less than 45, seek the degrees on the top, and the minutes in the left-hand column marked M, against which in the column signed at the top with the proposed name, stands the sine, tangent, and secant required; but when the degrees given are more than 45, seek the degrees at the bottom, and the minutes in the right-hand column marked M at the bottom, and the proposed name of the bottom. Here it may be observed, that the degrees at the top and minutes at the left-hand column, added to the degrees at the bottom and minutes in the right-hand column, always make 90; hence, if a sine be looked for, the co-sine or complement will be found in the adjoining column, the same of tangents and secants.

**EXAMPLE I.**—Required the log. sine of  $28^{\circ} 37'$ ?

Find 28 at the top of the page, and in the left-hand column marked M at the top, find 37; against which, in the column marked with the word Sine, stands 9.68029, the logarithm of the sine of  $28^{\circ} 37'$  required. The same may be observed of tangents and secants.

**EXAMPLE II.**—Required the log. tangent of  $67^{\circ} 45'$ ?

Find  $67^{\circ}$  at the bottom of the page, and  $45'$  at the right-hand column marked M at the bottom; against this in the column marked Tangent at the bottom, stands 10.38816, which is the logarithm required.

Having the sine, tangent, and secant, the co-sine, co-tangent, co-secant, are always found in the adjoining columns.

The logarithms to any number of degrees above  $90^{\circ}$ , is found by subtracting the given degrees from  $180^{\circ}$ , and taking the logarithm of the remainder; or if  $90^{\circ}$  be subtracted from the given sine, and the log. co-sine of the remainder be taken, it will give the same as above.

*To find the Degrees, Minutes, and Seconds, corresponding to any given Logarithm.*

If the degrees, minutes, and seconds, be wanted to a given logarithmic sine, or co-sine thus found, and the next greater and the next less than the given logarithm, and the difference between the given logarithm and next less if a sine, and the next greater if a co-sine; then say, as the difference between the next greater and next less to 60", so is the difference between the next less if a sine, and the next greater if a co-sine, to the number of seconds to be annexed to the degrees and minutes found before.

EXAMPLE I.—Find the degrees, minutes, and seconds, corresponding to log. sine 9.61405?

|                |         |                |         |
|----------------|---------|----------------|---------|
| Next less log. | 9.61382 | Next less log. | 9.61382 |
| Next greater   | 9.61411 | Given log.     | 9.61405 |
|                | <hr/>   |                | <hr/>   |
|                | 29      |                | 23      |

Here the given log. is found standing between  $24^{\circ} 16'$  and  $24^{\circ} 17'$ ; then as 29 is to 60, so is 23 to 48, which annexed to  $24^{\circ} 16'$ , gives  $24^{\circ} 16' 48''$ , answering to log. 9.61405.

EXAMPLE II.—Find the degrees, minutes, and seconds, corresponding to the log. co-sine 9.43297?

The nearest found between  $74^{\circ} 16'$  and  $74^{\circ} 17'$ .

|                   |         |                |         |
|-------------------|---------|----------------|---------|
| Next greater log. | 9.43323 | Next less log. | 9.43323 |
| Next less         | 9.43278 | Given log.     | 9.43297 |
|                   | <hr/>   |                | <hr/>   |
| Diff.             | 45      | Diff.          | 26      |

Now as 45 is to 60, so is 26 to  $34''$ , which annexed to  $74^{\circ} 16'$  gives  $74^{\circ} 16' 34''$ , the degrees, minutes, and seconds required.

*To find the Logarithm of the Sine or Co-sine, for Degrees, Minutes, and Seconds.*

RULE.—Find the logarithm to the degrees and minutes as before; take the difference between the logarithm and the next greater in the sine; but if a co-sine, the next less; multiply this difference by the odd seconds, and divide the product by 60'; add the quotient to the right-hand of the log. of the degrees and minutes, if a sine, but subtract it if a co-sine, the sum or difference will be the logarithm, sine, or co-sine required.



EXAMPLE I.—Required the  
log. sine of  $24^{\circ} 16' 48''$ ?

Sine of  $24^{\circ} 16'$  9.61382  
Sine of  $24^{\circ} 17'$  9.61411

Diff. 29

Now 29 multiplied by 48  
gives 1392; this divided by 60,  
the quotient is 23, which added  
to 9.61382, gives 9.61405, the  
log. of  $24^{\circ} 16' 48''$ .

EXAMPLE II.—What is the  
log. co-sine of  $74^{\circ} 16' 34''$ ?

Log. co-sine of  $74^{\circ} 16'$  9.43323  
Log. co-sine of  $74^{\circ} 17'$  9.43278

Diff. 47

Now 47 multiplied by 34 =  
1598; this divided by 60, gives  
the quotient 26 nearly; and 26  
subtracted from 9.43323, leaves  
9.43297, the log. co-sine of  
 $74^{\circ} 16' 34''$ .

If the given seconds be  $\frac{1}{2}$ ,  $\frac{1}{3}$ ,  $\frac{1}{4}$ ,  $\frac{1}{5}$ , or  $\frac{1}{6}$ , or any other even parts of a minute, the like parts may be taken of the difference of the logarithms, and added or subtracted as above, which may be frequently done by inspection.

*To find the Arithmetical Complement of any Logarithm.*

The complement arithmetic of any logarithm, is what it wants of 10.00000 or 20.00000, and is used to avoid subtraction. For finding it this is the rule: Take the residue or remainder of the first figure to 9, and so of the rest, till you come to the last figure; of which take its remainder under 10, and it is done.

EXAMPLE I.—I would have the complement arithmetic of 9.62595?

For the first figure 9 write 0; for 6, 3; for 2, 7; for 5, 4; for 9, 0; and for the last figure 5 write 5; and so you have 0.37405 for the complement arithmetic sought.

EXAMPLE II.—The complement arithmetic of 20.33133?

For 0 (rejecting the first figure) write 9, and so on as before directed, and then you will have 9.66869, which is the complement arithmetic of 20.33133. Or thus:

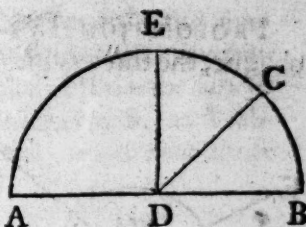
|      |          |      |          |
|------|----------|------|----------|
| From | 10.00000 | From | 20.00000 |
| take | 9.62595  | take | 10.33133 |
|      | 0.37405  |      | 9.66867  |

It will be necessary for the reader to make himself well acquainted with the following propositions, as he will find them useful when he goes into Trigonometry, which are here rendered plain and easy to be understood:

PROPOSITION I.—If a right line stands upon, or meets with another right line, and makes angles with it, the two angles taken together will be two right angles, or two angles equal to two right angles.

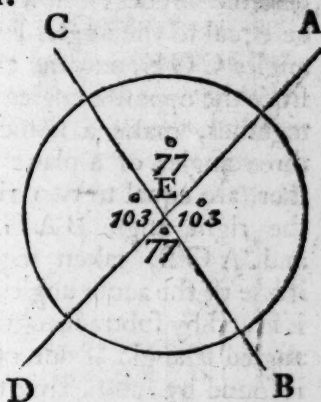
Let

Let the line  $CD$  meet  $AB$  in  $D$ ; on  $D$  erect the perpendicular  $DE$ , with the chord of  $60^\circ$  in your compasses, and one foot in  $D$ , describe the arch  $AEB$ , which will be a semicircle or  $180^\circ$ ; of which  $AB$  is the diameter, and the angles  $ADE$  and  $BDE$  are quadrants, each  $90^\circ$ , because  $ED$  is perpendicular to  $AB$ : now the  $BDC$  is less than  $90^\circ$ , since the two angles together can make neither more nor less than  $180^\circ$  or a semicircle; consequently any number of right lines standing upon the same side of the line  $AB$ , and coming from the same point  $D$ , the sum of all the angles formed by such right lines cannot exceed  $180^\circ$ . If the angle  $BDC$  be subtracted from  $180^\circ$ , the remainder will be the angle  $CDA$ ; or if the angle  $ADE$  is given, the angle  $BDC$  is found in the same manner.



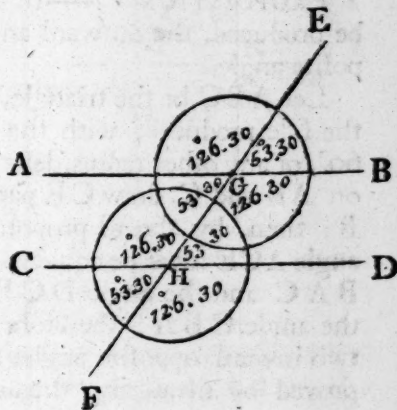
**PROPOSITION II.**—If two right lines cross each other, the angles which are opposite are equal one to the other.

Let the two lines  $AD$  and  $CB$  cross each other in the point  $E$ . With the chord of  $60^\circ$ , or any convenient radius, in your compasses, and one foot in  $E$ , describe a circle; then, by measuring the angles, it will be found that the angle  $AEB$  is equal to the angle  $CED$ , and that the angle  $AEC$  is equal to the angle  $BED$ ; for the angle  $AEB$  added to the angle  $AEC$  make a semicircle; and so does the angles  $BED$  and  $DEC$ ; and all the angles taken together make  $360^\circ$ .



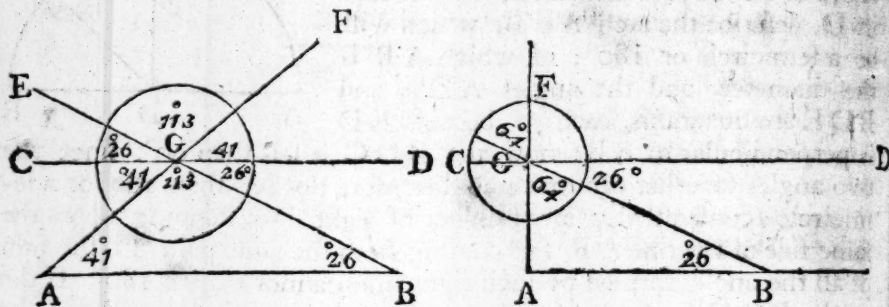
**PROPOSITION III.**—If a right line cross two parallel lines, the outward angles will be each equal to the inward and opposite ones.

Let the lines  $AB$  and  $CD$  be parallel lines, and  $EF$  the line that cuts them in the points  $G$  and  $H$ . With the chord of  $60^\circ$  in your compasses, and one foot on  $G$  and  $H$ , describe the arches  $BEA$  and  $DFC$ , which will be each a semicircle: now, by measuring the angles  $BGE$  and  $AGE$ , they will be found equal to the angles  $DHF$  and  $FHC$ , and each equal to  $180$ , by the first proposition. In like manner it may be proved, that the two outward angles are equal to the two inward and opposite ones.



PRO-

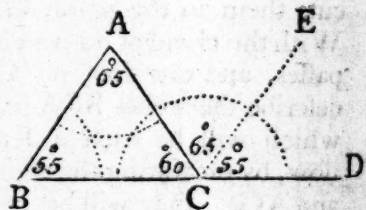
PROPOSITION IV.—In every plane triangle, whether right or oblique, the three angles are equal to two right angles or  $180^\circ$ .



In the triangle  $AGB$  draw  $CD$  parallel to  $AB$  through the point  $G$ ; on which point, with the chord of  $60^\circ$ , or any convenient radius, describe a circle on the point  $G$ ; and with the same radius, on  $A$  and  $B$ , describe arches: now, by the last proposition, the angle  $AGB$  will be equal to the angles  $FGE$ , and the angle  $ABG$  will be equal to the angles  $CGE$ , and the angle  $BAG$  is equal to the angle  $DGF$ : now, since the opposite angles are equal, the angles  $DGF$ ,  $FGE$ , and  $EGC$ , together, make a semicircle or  $180^\circ$ ; therefore it is plain, that the three angles of a plane triangle, whether right, acute, or obtuse, together, are equal to two right angles or  $180^\circ$ : hence it follows that, as the right angle  $BAG$  is  $90^\circ$ , the other two acute angles  $ABG$  and  $AGB$ , taken together, can be no more than  $90^\circ$ ; therefore if one of the acute angles, in a right-angled triangle, be given, the other is found by subtracting the given angle from  $90^\circ$ . And in any oblique-angled triangle, if one of the angles be given, the sum of the other two is found by subtracting the given angle from  $180^\circ$ ; and if two angles are given, the third is found by subtracting the sum of the two angles from  $180^\circ$ .

PROPOSITION V.—In every plane triangle, if one of its sides be produced, the outward angle will be equal to the two inward opposite angles.

Let  $ABC$  be the triangle, and  $CD$  the side produced, with the chord of  $60^\circ$ , or any other radius, describe arches on  $AB$  and  $C$ , draw  $CE$  parallel to  $AB$ ; then, by the 3d proposition, the angle  $ACE$  must be equal to the angle  $BAC$  and the angle  $DCE$  equal to the angle  $CBA$ ; therefore the outward angle  $DCA$  is equal to the two inward opposite angles  $ACB$  and  $BAC$ ; which may be easily proved by measuring the angles by the line of chords on the plane scale.



NOTE.



**NOTE.**—I hope the learned mathematician will excuse the method here taken of demonstrating the above propositions in a mechanical manner, judging it best adapted to the capacity of those for whose use this book is intended, not doubting but the teacher will, as I always do, demonstrate them in a more geometrical manner to those who are capable of receiving such.

## TRIGONOMETRY.

**PLANE** Trigonometry is the art of measuring plane triangles, by comparing the sides and angles together by known analogies; where, by three things being given, a fourth may be found, on condition that one of them be a side: but as angles are measured by the arch of a circle, described upon their angular points, and the proportions that these arches bear to right lines cannot be exactly found; therefore the writers of Trigonometry have applied right lines to these arches, that the proportion they bear to the sides of a plane triangle may be found.

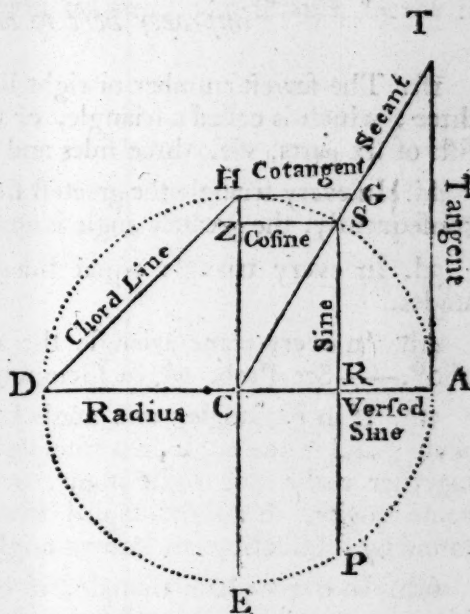
The right lines applied to a circle are:

1st. A **CHORD**, or the substance of an arch, is a right line that divides the circle into two unequal parts, and is a chord to them both, as DH is the chord of the arches DH and DAH.

2d. A **RIGHT SINE** of an arch, as a right line drawn from one end or termination of an arch perpendicular to the radius, or it is half the chord of twice the arch; so that RS is the sine of the arch AS, and SZ the cofine.

3d. A **VERSED SINE** is that part of the diameter contained between the right sine, and the arch, as RA and RCD, and is the versed sine of SHD, or DEP its equal.

4. A **TANGENT** of an arch, is a right line drawn perpendicular to one end of the diameter, just touching the arch, as AT is the tangent of the arch, AS and HG the co-tangent.



5. A **SE-**

5. A SECANT of an arch is a right line drawn from the center through the circumference, and produced until it cuts the tangent, as C T.

NOTE. The fine, tangent, and secant of the complement of an arch, is called the co-fine, co-tangent, and co-secant of that arch.

The fines, tangents, and secants of an arch, are said to be the measure of so many degrees, as that arch contains parts of 360 degrees; so that the radius being the fine of a quadrant, or a fourth part of a circle, contains  $90^\circ$ , thus: the radius is always equal to the fine of  $90^\circ$ , as is the chord of  $60^\circ$  and the tangent of  $45^\circ$ , all the three being each equal to the radius; and that the fine, tangent, and secant of an arch, is equal to the fine, tangent, and secant of an arch, as much above  $90$  degrees as the former was deficient of  $90$ ; thus the fine, tangent, or secant of  $80^\circ$  is  $= 100^\circ$ , of  $70^\circ$  is  $110^\circ$ , of  $60^\circ$  is  $= 120^\circ$ ; of  $40'$  is  $= 140^\circ$ , &c. so that in taking out the logarithms of fines, tangents, or secants, for any number of degrees above  $90^\circ$ , the given angle must be subtracted from  $180^\circ$ , and the logarithm of the remainder be taken; or subtract  $90^\circ$  from the given angle, and take the log. co-fine, co-tangent, or co-secant of the remainder.

*Notwithstanding what has been said in Geometry, it may not be improper here to observe that,*

1st. The fewest number of right lines that can include a space are three; which is called a triangle, or three-cornered figure, and consists of six parts, viz. three sides and three angles.

2d. In every triangle the greatest side is opposite the greatest angle; consequently, the greatest angle is opposite the greatest side.

3d. In every triangle equal sides subtend or stand against equal angles.

4th. In every plane triangle the three angles together are equal  $180^\circ$ .—See Prob. 3d, in Geometry.

5th. If in a triangle, one angle be right or obtuse, the rest are acute; and if one angle in a triangle be right, the other two taken together make one right angle, or  $90^\circ$ ; wherefore if one of the acute angles, in a right-angled triangle, be known, the other is found by subtracting the known angle from  $90^\circ$ .

6th. In every plane triangle, if one of the angles be given or known, the sum of the other two is found by subtracting the given angle from  $180^\circ$ ; and if two of the angles be known or given, the third is found by subtracting their sum from  $180^\circ$ .

7th. The complement of an angle is what it wants of  $90^\circ$ .

8th. The

8th. The supplement of an angle is what it wants of  $180^{\circ}$ .

9th. All angles are measured by the arch of a circle, described about their angular points with the chord of  $60^{\circ}$ , and are said to be greater or less, according to the number of degrees or parts to be contained between their legs; which legs may be supposed to be yards, miles, leagues, &c.; and are measured on a scale of equal parts.

10th. A circle described with a chord of  $60^{\circ}$ , the circumference, will contain four right angles or  $360^{\circ}$ , the quadrant  $90^{\circ}$ , and semi-circle  $180^{\circ}$ .

11th. The angles of two triangles may be respectively equal, although their sides may be unequal. Therefore, among the things given, in order to find the rest, one of them must be a side.

In Trigonometry the three parts given in all triangles, must be either,

- 1st. Two sides and an angle opposite one of them.
- 2d. Two angles and a side opposite one of them.
- 3d. Two sides and the included angle.
- 4th. Three sides.

In either cases, the other three things may be found by help of the table of logarithms, artificial sines, tangents, and secants, by the following axioms:



*The Solution of the several Cases in Plane Trigonometry depend upon four Propositions called Axioms, which the Learner should get perfectly by heart.—We shall here give the first Axiom only, and the rest before we begin Oblique Sailing.*

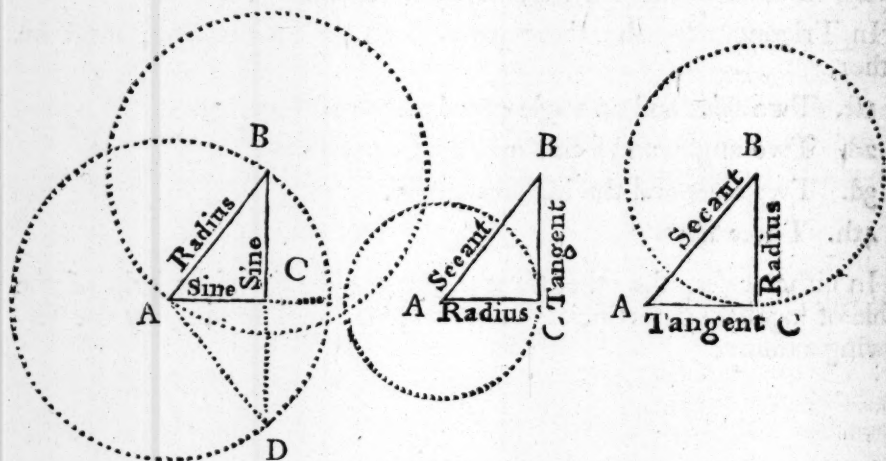
### A X I O M . I.

In any right-angled plane triangle,

If the hypotenuse be made the radius of a circle, the other two sides, or legs, will be the fines of their opposite angles ; but

If either of the legs, including the right angle, be made the radius of a circle, the other leg will be the tangent of its opposite angle, and the hypotenuse the secant of the same angle ;

For let the three following triangles have their sides and angles equal:



It is plain, by comparing these with the first figure in Trigonometry, that taking the hypotenuse  $AB$  as radius in your compasses, and on  $A$  and  $B$  describe circles,  $CB$  will be the sine of the angle  $BAC$ , and  $CA$  will be the sine of the angle  $ABC$ , and  $BC$  will be the sine of half the arch  $BD$ , or the sine of half the angle  $BAD$ , being half the chord of twice the arch ; but taking the base  $AC$  as a radius in your compasses, and with one foot in  $A$  describe a circle, it is plain that  $CB$  will be the tangent, and  $AB$  the secant of the same angle ; but if  $CB$ , the perpendicular, be taken as the radius, and a circle be described on  $B$ , then will  $AC$  be the tangent of its opposite angle  $ABC$ , and the hypotenuse the secant of the same angle : for it should be remembered, that when any one of the legs becomes a tangent of its opposite angle, the hypotenuse always accompanying it, becomes the secant of the same angle.

Now, since, by making any of the sides of a right-angled triangle the radius of a circle, we can readily find the names or denominations of the other side, it comes next to be considered what parts or things are given, and what required, in order to state the question.

In

In this case we shall compare Trigonometry with the Rule of Three in common arithmetic; where we are taught to consider what name or denomination the answer is to be of, which names must always be made the second term in stating the question; if pounds are to be the fourth number, or answer, then pounds must be the second term; if yards are to be the answer, then yards must be the second term. As for example, if 60 yards cost £120, what will 90 yards cost? Then pounds being wanted, pounds must be the second term.

If 60 yards cost £120, what will 90 yards cost?

$$\begin{array}{r} 90 \\ \hline 60 \overline{)1080(0} \\ \hline \end{array}$$

180 Answer.

It is the same in Trigonometry; for if the fourth number, or answer, is to be an angle, an angle implied must be the second term, and sides the first and third terms: but when a side is required, it must be placed the second term, and angles the first and third terms, in stating the question; consequently, in all questions in Trigonometry, if a side is required, you must begin with an angle or radius, which is always considered as a given angle equal to  $90^\circ$ ; but when an angle is required, then you must begin with a known side.

In the Rule of Three we multiply the second and third terms together, and divide that product by the first term, and the quotient will be the fourth number sought, and of the same denomination the second term is of. Now, since addition of logarithms answers the purpose of multiplication of whole numbers, and subtraction that of division, add the logarithms of the second and third term together, and from their sum subtract the logarithm of the first term, the remainder will be the logarithm of the fourth term.

|                 |    |     |     |         |
|-----------------|----|-----|-----|---------|
| As log.         | —  | 60  | —   | 1.77815 |
| Is to log. of   |    | 120 | —   | 2.07918 |
| So is log.      | —  | 90  | —   | 1.95424 |
|                 |    |     |     | <hr/>   |
|                 |    |     | Add | 4.03342 |
| First term sub. | 60 | is  |     | 1.77815 |
|                 |    |     |     | <hr/>   |
| To answer       |    | 180 | =   | 2.25527 |

Here it is plain the logarithms give the same answer as that given by the Rule of Three.

In a right-angled triangle there are always two sides, or the angles and one side given, to find the rest.

To find a side, any side may be made radius; then say, as the name of the given side is to the given side, so is the name of the side required

required to the side required, which must be found among the logarithms.

To find an angle, one of the given sides must be made radius; then say, as the side made radius is to radius, so is the other given side to the sine, tangent, or secant, by it represented; which being looked for in the table of sines, tangents, and secants, where will be found the degrees and minutes corresponding to the angle required.

### *Solution of the Six Cases in Right-angled Trigonometry,*

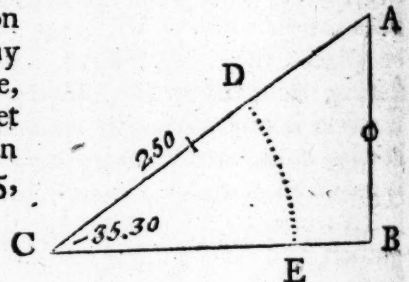
#### CASE I.

*The Angle and Hypotenuse given, to find the Legs.*

Given, the Hypotenuse AC 250 Leag. and the Angle opposite to the Base CB =  $54^{\circ} 30'$ , to find the Base CB and Perpendicular AB,

#### By CONSTRUCTION.

Draw the base CB of any length, on C describe the arch DE, from E to D lay off  $35^{\circ} 30'$ , thro' C and D draw a line, which must be equal to 250; from A let fall the perpendicular AB, to cut CB in B, and it is done; for CB will be 203.5, and AB = 145.2.



#### By CALCULATION.

By making the Hypotenuse CA Radius, it will be,

To find the Base BC.

|                                    |          |
|------------------------------------|----------|
| As radius                          | 10.00000 |
| Is to the hypoth. CA 250           | 2.39794  |
| So is sine ang. A $54^{\circ} 30'$ | 9.91069  |
|                                    | <hr/>    |
|                                    | 12.30863 |
|                                    | <hr/>    |
|                                    | 10.00000 |

To the base BC 203.5      2.30863

To find the Perpendicular AB.

|                                    |          |
|------------------------------------|----------|
| As radius                          | 10.00000 |
| Is to the hypoth. CA 250           | 2.39794  |
| So is sine ang. C $35^{\circ} 30'$ | 9.76395  |
|                                    | <hr/>    |
|                                    | 12.16189 |
|                                    | <hr/>    |
|                                    | 10.00000 |

To the per. AB 145.2      2.16189

By making the Base Radius, the Proportion by Axiom the first, will be,

To find the Base BC.

|                                 |          |
|---------------------------------|----------|
| As sec. ang. C $35^{\circ} 30'$ | 10.08931 |
| Is to hypo. AC = 250            | 2.39794  |
| So is radius                    | 10.00000 |
|                                 | <hr/>    |
|                                 | 12.39794 |
|                                 | <hr/>    |
|                                 | 10.08931 |

To the base BC = 203.5      2.30863

To find the Perpendicular AB.

|                                     |          |
|-------------------------------------|----------|
| As sec. ang. C $35^{\circ} 30'$     | 10.08931 |
| Is to hypo. AC = 250                | 2.39794  |
| So is tang. ang. C $35^{\circ} 30'$ | 9.85327  |
|                                     | <hr/>    |
|                                     | 12.23121 |
|                                     | <hr/>    |
|                                     | 10.08931 |

To the per. AB 145.2 = 2.16190

By



By making the Perpendicular Radius, by Axiom the first, it will be,

| To find the Base B C. |         |           | To find the Perpendicular A B. |         |           |
|-----------------------|---------|-----------|--------------------------------|---------|-----------|
| As sec. ang. A        | 54° 30' | 10. 23605 | As sec. ang. A                 | 54° 30' | 10. 23605 |
| Is to hypoth. A C     | 250     | 2. 39794  | Is to hypoth. A C              | 250     | 2. 39794  |
| So is tang. ang. A    | 54° 30' | 10. 14673 | So is radius                   |         | 10. 00000 |
|                       |         | <hr/>     |                                |         | <hr/>     |
|                       |         | 12. 54467 |                                |         | 12. 39794 |
|                       |         | 10. 23605 |                                |         | 10. 23605 |
|                       |         | <hr/>     |                                |         | <hr/>     |

To the base BC = 203,5 2. 30862 To the per. = AB 145,2 2. 16189

NOTE. In the first stating, where the hypotenuse is made radius, the sum of the logarithms of the second and third terms are, 12. 30863; from which it is easy to subtract the logarithm of the first term; for you may either cancel it, or leave it out; and then cast off the first figure towards the left hand, and it will leave the logarithm 2.30863, the same as if 10.00000 had been set down and subtracted from it; and indeed, the five cyphers may be always omitted in the radius, and only the index 10. set down.

It will greatly expedite the working the proportions by logarithms, if the two or all the statings be first made, and then the sines, tangents, or secants, may be taken out at one opening of the book; for if one angle of a right-angled triangle be given, the logarithm of its complement, or the other angle, whether sine, tangent, or secant, is found in the adjoining column, without being at the trouble of subtracting the given angle from 90°. If the given angle be less than 45 degrees, it is found at the top of the table, and the minutes in the left hand column, reckoned downwards; and its complement is found at the bottom, and the minutes on the right hand column. On the contrary, if the given angle is found at the bottom, its complement, or the other angle, will be at the top of the table, and the minutes in the left hand column, against which is the log. sine, tangent, or secant, corresponding to it.

### By GUNTER's SCALE.

In all proportions wrought by Gunter's scale, when the first and second terms are of the same kind, then the extent from the first term to the second, will reach from the third to the fourth;

Or when the first and third terms are of the same kind,

The extent from the first term to the third, will reach from the second to the fourth; that is, set one point of the compasses on the division expressing the first term, and extend the other point to the division expressing the second term, then, without altering the opening of the compasses, set one point on the division representing the third term, or second term, and the other point will fall on the division shewing the fourth term or answer.

Now, in this last case, it will be thus:

Extend

Extend from radius, or  $90^\circ$  to  $54^\circ 30'$  on the line of sines, that extent will reach from 250, the hypotenuse, to 203.5, the base, on the line of numbers; and the extent from radius, or sine of  $90^\circ$  to  $35^\circ 30'$  on the line of sines, will reach from 250 to 145 on the line of numbers.

Observe the like in all that follows, except in those proportions where the word secant is mentioned, which may be readily wrought by considering the hypotenuse radius, as in the last case; there being no line of secants on Gunter's Scale.

NOTE. The radius, according to the nature of the proportion, may be any of these:

8 Points on the Line of Rhumbs, |  $90^\circ$  On the Line of Sines.  
4 Points on the Line of Tan. Rhbs. |  $45^\circ$  On the Line of Tangents.

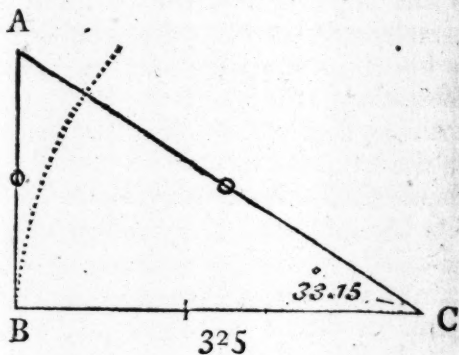
### CASES II. and III.

*The Angles and one Leg given, to find the Hypotenuse and other Leg.*

The Angle  $ACB$   $33^\circ 15'$ , the Leg  $BC$  325 Miles given, to find the Hypotenuse and the other Leg.

#### By CONSTRUCTION.

Draw the line  $BC$ , which make equal to 325 miles; on  $B$  erect the perpendicular  $BA$ ; on  $C$  describe an arch with the chord of  $60^\circ$ , and make the angle  $C = 33^\circ 15'$ , through where that cuts the arch draw  $AC$  to cut  $AB$  in  $A$ , and it is done; for  $BA$  being measured on the same scale that  $BC$  was, will be 213.1 and  $AC$  382.6 miles.



By making the Hypotenuse  $AC$  Radius, it will be,

To find the Perpendicular  $AB$ .

As sine ang.  $A$   $56^\circ 45'$  9.92235  
Is to the base  $BC$  325 2.51188  
So is sine ang.  $C$   $33^\circ 15'$  9.73901

12.25089  
9.92235

To the perpen.  $AB$  213.1 2.32854

To find the Hypotenuse  $AC$ .

As sine ang.  $A$   $56^\circ 45'$  9.92235  
Is to the base  $BC$  325 2.51188  
So is radius  $90^\circ$  10.00000

12.51188  
9.92235

To the hypoth.  $AC$  388.6 2.58953

By

By making the base BC Radius, it will be,

To find the Perpendicular AB.

|                            |          |
|----------------------------|----------|
| As radius 90°              | 10.00000 |
| Is to the base BC 325      | 2.51188  |
| So is tang. ang. C 33° 15' | 9.81666  |
|                            | <hr/>    |
|                            | 12.32854 |
|                            | <hr/>    |
|                            | 10.00000 |

To the perpen. AB 213,1 2.32854

To find the Hypothenufe AC.

|                           |          |
|---------------------------|----------|
| As radius 90°             | 10.00000 |
| Is to the base BC 325     | 2.51188  |
| So is sec. ang. C 33° 15' | 10.07765 |
|                           | <hr/>    |
|                           | 12.58953 |
|                           | <hr/>    |
|                           | 10.00000 |

To the hypoth. AC 388,6 2.58953

By making the Perpendicular AB Radius, it will be,

To find the Perpendicular AB.

|                         |          |
|-------------------------|----------|
| As tang. ang. A 56° 45' | 10.18334 |
| Is to the base BC 325   | 2.51188  |
| So is radius 90°        | 10.00000 |
|                         | <hr/>    |
|                         | 12.51188 |
|                         | <hr/>    |
|                         | 10.18334 |

To the perpen. AB 213,1 2.32854

To find the Hypothenufe AC.

|                           |          |
|---------------------------|----------|
| As tang. ang. A 56° 45'   | 10.18334 |
| Is to the base BC 274     | 2.51188  |
| So is sec. ang. A 56° 45' | 10.26099 |
|                           | <hr/>    |
|                           | 12.77287 |
|                           | <hr/>    |
|                           | 10.18334 |

To the hypoth. AC 388,6 2.58953

By G U N T E R.

' Extend from 56 degrees 45 minutes to 33 degrees 15 minutes on the line of fines, that extent will reach from the base 325 to the perpendicular 213,1 on the line of numbers.'

2dly. ' Extend from 56 degrees 45 minutes to radius on the line of fines, that extent will reach from the base 325 to the hypothenufe 388,6 on the line of numbers.'

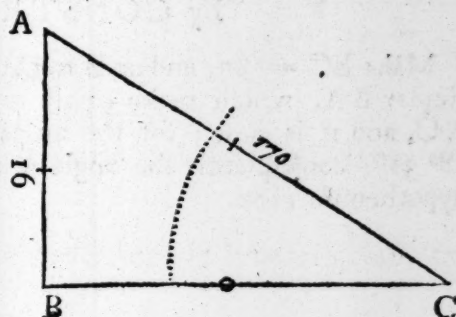
C A S E IV. and V.

*The Hypothenufe and one Leg given, to find the Angles and other Leg.*

The leg AB 91, the Hypothenufe 170 given, to find the Angle ACB, or BAC, and the leg BC.

By CONSTRUCTION.

Draw BC at pleasure, on B erect the perpendicular BA, which make equal to 91; take 170 in your compasses, and with one foot on A, lay the other on the line BC, and join A and C, and it is done; for the angle C will be 32° 22', the angle A 57° 38' and BC 143,6.



By



By making the Hypothenuſe Radius, it will be,

To find the angle C.

|                            |          |
|----------------------------|----------|
| As the hypothenuſe 170     | 2.23045  |
| Is to the radius           | 10.00000 |
| So is the perpendicular 91 | 1.95904  |
|                            | <hr/>    |
|                            | 11.95904 |
|                            | 2.23045  |
|                            | <hr/>    |

To ſine angle C  $32^{\circ} 22'$  9.72859

To find the baſe CB.

|                                    |          |
|------------------------------------|----------|
| As Radius                          | 10.00000 |
| Is to the hypoth. 150              | 2.23045  |
| So is ſine ang. A $57^{\circ} 38'$ | 9.92667  |
|                                    | <hr/>    |
|                                    | 12.15712 |
|                                    | 10.00000 |
|                                    | <hr/>    |

To the baſe 143,6 2.15712

By making the Perpendicular Radius, it will be,

To find the Angle A.

|                         |          |
|-------------------------|----------|
| As the perpendicular 91 | 1.95904  |
| Is to the radius        | 10.00000 |
| So is the hypoth. 150   | 2.23045  |
|                         | <hr/>    |
|                         | 12.23045 |
|                         | 1.95904  |
|                         | <hr/>    |

To ſec. ang. A  $57^{\circ} 38'$  10.27141

To find the Baſe BC.

|                                   |          |
|-----------------------------------|----------|
| As the radius                     | 10.00000 |
| Is to the perpend. 91             | 1.95904  |
| So is tang. ang. $57^{\circ} 38'$ | 10.19805 |
|                                   | <hr/>    |
|                                   | 12.15709 |
|                                   | 10.00000 |
|                                   | <hr/>    |

To the baſe 143,6 2.15709

By G U N T E R.

‘ Extend from hypothenuſe 170 to the perpendicular 69 on the line of numbers; that extent will reach from radius to ſine angle C 32 degrees 22 minutes on the line of ſines.’

2dly. ‘ Extend from radius to ſine angle A 57 degrees 38 minutes; that extent will reach from the hypothenuſe 170 to the baſe 243 on the line of numbers.’

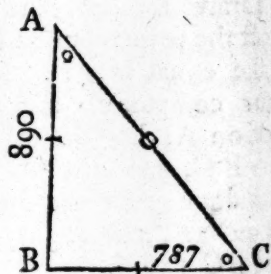
### C A S E VI.

*The Legs given, to find the Angles and Hypothenuſe.*

The Legs AB 890, BC 787 given, to find the Angle BAC, or ACB, and the Hypothenuſe AC.

By CONSTRUCTION.

Make BC = 787, and on B erect the perpendicular BA, which make equal to 890; join AC, and it is done; for the angle C will be  $48^{\circ} 31'$ ; conſequently the angle A  $41^{\circ} 29'$  and hypothenuſe 1188.



By

By making the Base Radius, it will be,

To find Angle C.

|                        |          |
|------------------------|----------|
| As the base 787        | 2.89597  |
| Is to radius           | 10.00000 |
| So is the perpend. 890 | 2.94939  |
|                        | 12.94939 |
|                        | 2.89597  |

To tang. ang.  $48^{\circ} 31'$  10.05342

To find the Hypoth. A C.

|                                    |          |
|------------------------------------|----------|
| As radius                          | 10.00000 |
| Is to the base 787                 | 2.89597  |
| So is sec. ang. C $48^{\circ} 31'$ | 10.17888 |
|                                    | 13.07485 |
|                                    | 10.00000 |

To the hypoth. 1188 3.07485

By making the Perpendicular Radius, it will be,

To find Angle A.

|                     |          |
|---------------------|----------|
| As the perpend. 890 | 2.94939  |
| Is to radius        | 10.00000 |
| So is the base 787  | 2.89597  |
|                     | 12.89597 |
|                     | 2.94939  |

To tang. ang. A  $41^{\circ} 29'$  9.94658

To find the Hypoth. AC.

|                                    |          |
|------------------------------------|----------|
| As radius                          | 10.00000 |
| Is to the perpend. 890             | 2.94939  |
| So is sec. ang. A $41^{\circ} 29'$ | 10.12543 |
|                                    | 13.07482 |
|                                    | 10.00000 |

To the hypoth. 1188 3.07482

By G U N T E R.

The extent from 787 to 890 on the line of numbers, will reach from radius (or 45 degrees) to  $41^{\circ} 29'$  on the line of tangents.

2dly. The extent from fine angle A 48 degrees 31 minutes to radius, or 90 degrees, will reach from the base 787 to the hypotenuse 1188, on the line of numbers.

Questions to exercise the Learner in Trigonometry.

Quest. 1. The hypotenuse 496 miles, and the angle opposite to the base  $56^{\circ} 15'$  given, to find the base and perpendicular.

Ans. Base 412,4, and the perpendicular 275,6 miles.

Quest. 2. The perpendicular 275 leagues, and the angle opposite to the base,  $56^{\circ} 15'$  given, to find the hypotenuse and base.

Ans. The hypotenuse 495, and base, 411,6 leagues.

Quest. 3. The base 33 yards, and the angle opposite to the perpendicular  $53^{\circ} 26'$  given, to find the hypotenuse and perpendicular.

Ans. Hypotenuse  $55^{\circ} 39'$  and the perpendicular, 44,49 yards.

Quest. 4. The hypotenuse 575, and perpendicular 50 miles given, to find the base.

Ans. Base 283,6 miles.

Quest. 5. The hypotenuse 59 and the base 33 miles given; to find the perpendicular.

Ans. Perpendicular 48,9 miles.

Quest. 6. The base 33, and perpendicular 52 leagues given, to find the hypotenuse.

Ans. Hypotenuse 61,59 leagues.

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I N T R O D U C T I O N

T O T H E

A R T O F N A V I G A T I O N.

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**B**EFORE we begin Navigation, it may not be improper to give the Learner some idea of the System of the Universe, commonly called the Solar, or Copernican System, which is as follows:

The Sun, that immense and amazing globe of fire, the fountain of the heat and light of the whole system, is placed near the common center of the orbits of seven opaque spherical bodies, which make their revolutions round it in less or more time, according to their several distances from it.

Mercury is nearest to the Sun, and receives its light and heat from it, and revolves round it in an ellipsis in two months and twenty-eight days.

Venus is somewhat higher in the system, and describes its ellipsis round the Sun in seven months and fifteen days, and becomes our evening and morning star by turns.

The Earth is next to Venus, and describes an ellipsis round the Sun in  $365\frac{1}{4}$  days, or one year, which being at a greater distance from the Sun than the former planets, and therefore receiving less of its light and heat, to make up the deficiency, the wise Author of nature has caused a secondary planet, called the Moon, to move round it in 27 days, 12 hours, and 44 minutes; it receives its light and heat from the Sun, and reflects it upon the Earth, which in some measure compensates for the absence of the Sun, during the winter seasons, in the North and South.

Mars is still higher in the system, and takes a larger circuit, revolving round the Sun in 1 year, 10 months, and 22 days.

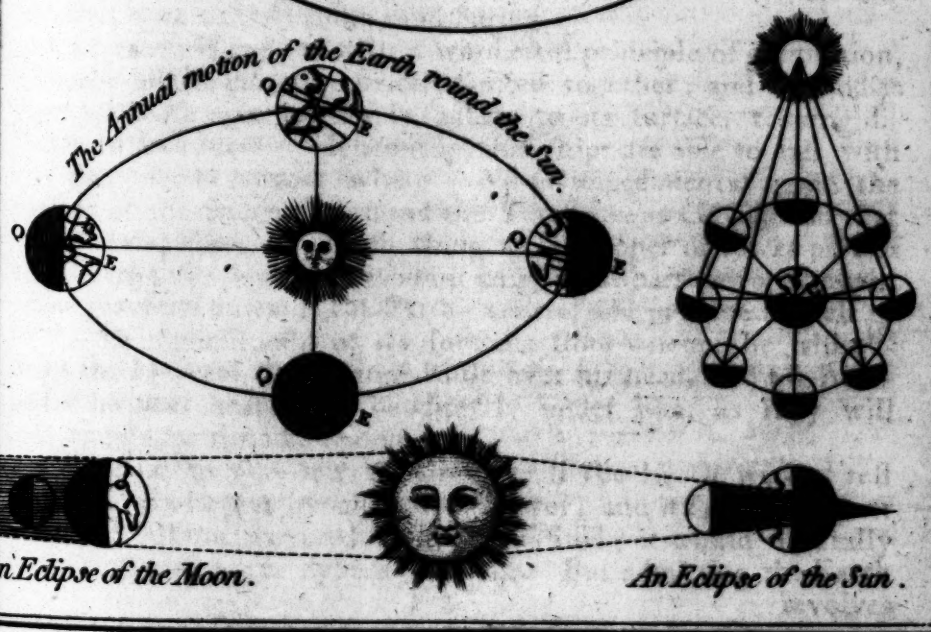
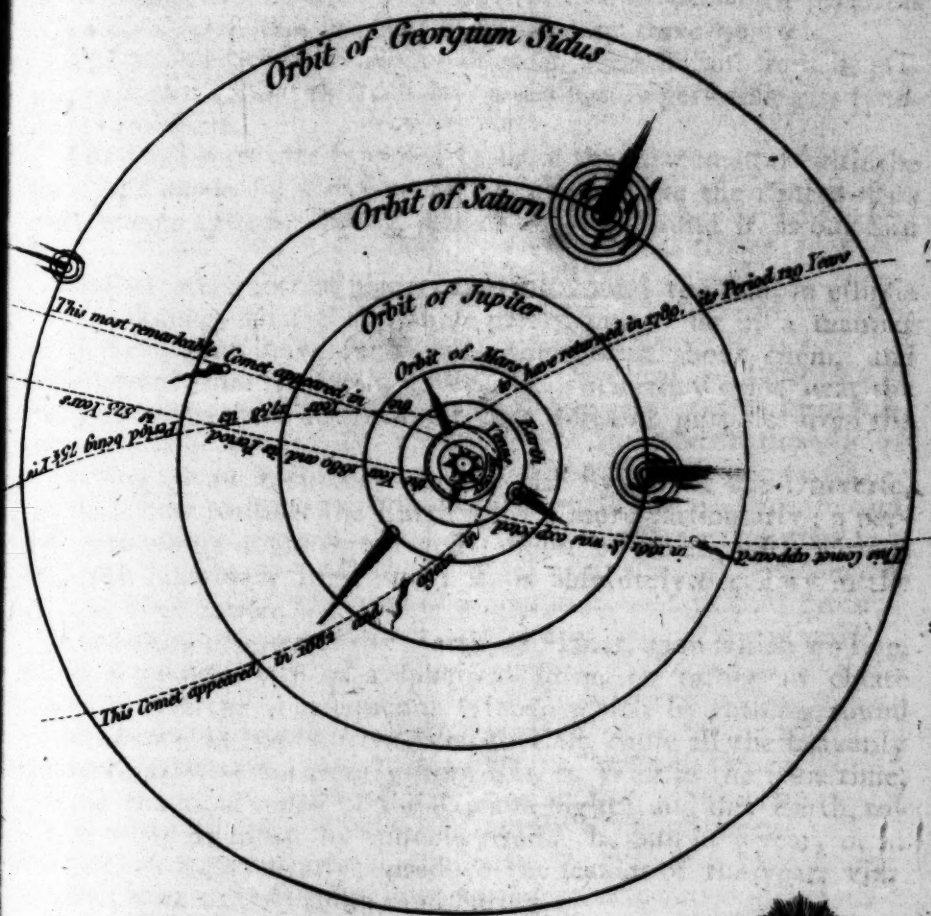
Jupiter is the largest of all the planets, and describes a large ellipsis round the Sun in 11 years, 10 months, 27 days; there are four Satellites or Moons moving round it; they receive their light from the Sun, and reflect it upon their primary planet, as the Moon does upon the Earth.

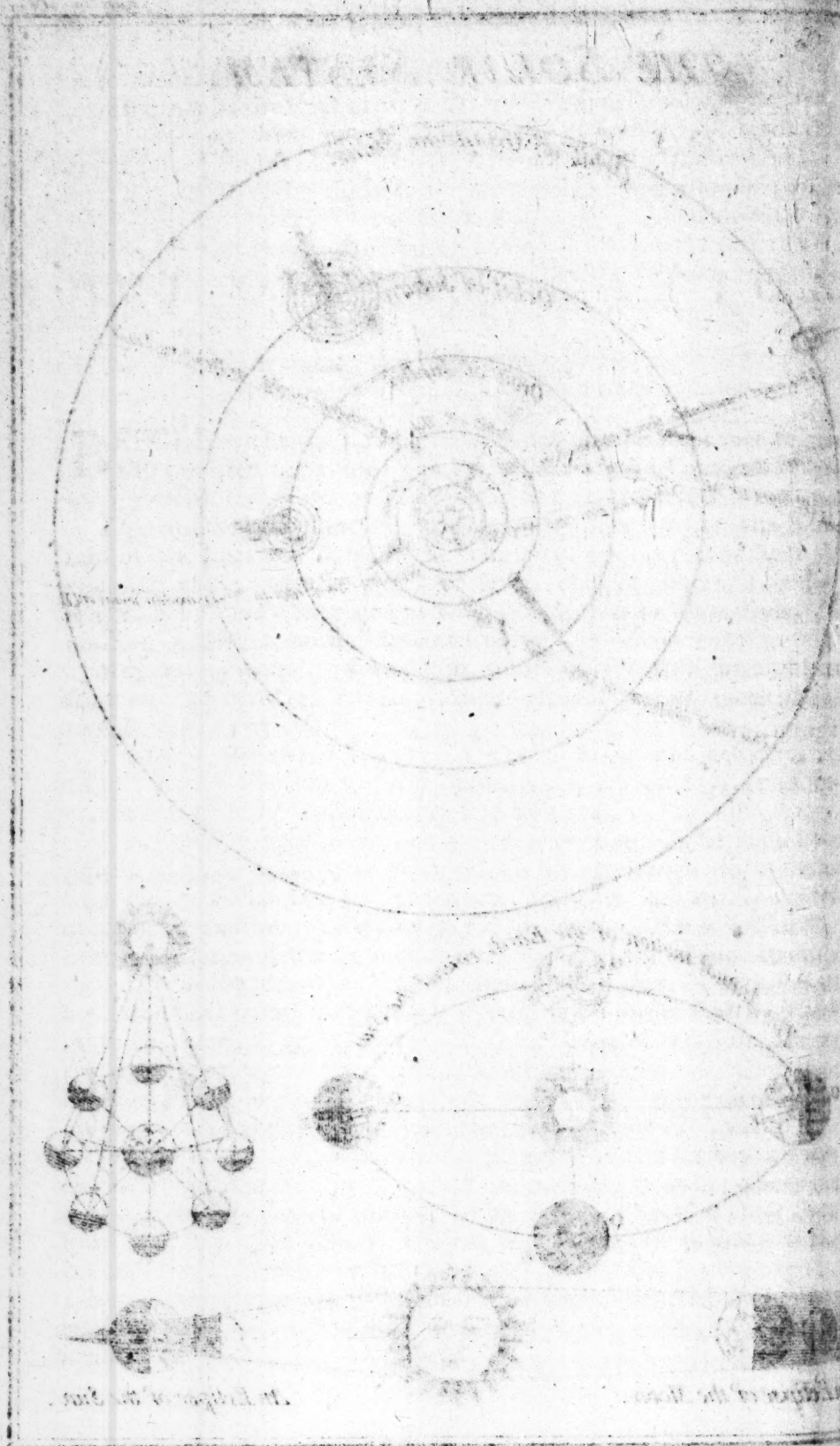
Saturn revolves round the Sun in  $29\frac{1}{2}$  years, has 5 Moons which move round him, and is also surrounded with a prodigious ring or atmosphere.

The



# THE SOLAR SYSTEM.





The *Georgium Sidus*, is the most remote of all the planets, and is attended by two satellites:—the first or nearest of which performs a synodical revolution in about eight days and three-quarters.

The second (which is about half as far again distant from its primary planet) is about thirteen days and a half in performing its synodical revolution.

The fixed stars, are supposed to be of the same matter with the Sun, and made for the same ends; each of them the centre of its own proper system, having planets moving round it as our Sun has.

Comets are a sort of planets moving round the Sun, in ellipsis so very oblong, that their visible parts seem to be in a manner parabolical, but have such vast atmospheres about them, and tails derived from the same, especially when they come near the Sun, as imply them designed for very different purposes from the other planets.

Having given a cursory view of the System of the Universe, we shall now consider the Earth a little more particularly; a perfect knowledge of the figure and motion of which, with various real and imaginary lines upon it, is absolutely necessary in the Art of Navigation.

The land and water of this Earth, or Planet, upon which we live, make a composition of a spherical form, or rather an oblate figure, called the *Terraqueous Globe*, which by turning round its axis every 24 hours, from West to East, cause all the heavenly bodies to revolve apparently from East to West in the same time, making the vicissitudes of the day and night; and this Earth, together with its moon by moving round the Sun in 1 year, or in 365 days 6 hours nearly, produce the seasons of the year, viz. Winter, Summer, Autumn, and Spring.

The Earth is endued with a wonderful principle of gravitation, whereby all its parts are strictly united together; and all bodies that are loose upon it, closely adhere to its surface, tending directly to its centre. Hence it is, that ships are able to sail with the same facility every where (void of impediments) upon the surface of the Sea, quite round the *Terraqueous Globe*, and that (as to sense) there is no such thing as an upper or lower part of the Earth; for let the inhabitant be in what part soever, he will there gravitate towards the Earth's centre, and imagine himself to be on the highest point of its surface; from whence he will observe the Heavens like a large vault over his head, and his Antipodes he will imagine to be directly under him, as they will also their's for the like reason.

According to this law of Gravity, if the Earth were at rest (and not acted upon by any other power) and its parts loose, or its surface all over covered with a deep fluid; it would naturally form itself into a true Sphere or Globe. But admitting the Earth



revolves about its own axis, with a rapid motion (from West to East) in 24 hours, the gravity towards its centre will thereby be disturbed, and all the parts endeavour to fly off from the axis of the motion; and this inclination is greatest in that part of the surface, which is at the greatest distance from the axis; and consequently, the gravity towards the centre is there the least; whence it will follow, that those parts which gravitate the least, must yield or give way to those that have a greater gravitation, to restore an equilibrium; and consequently, here will be formed a Spheroid, whose greatest diameter will be perpendicular to the axis of motion, (commonly called the Earth's axis) and the shortest diameter will be the axis itself.

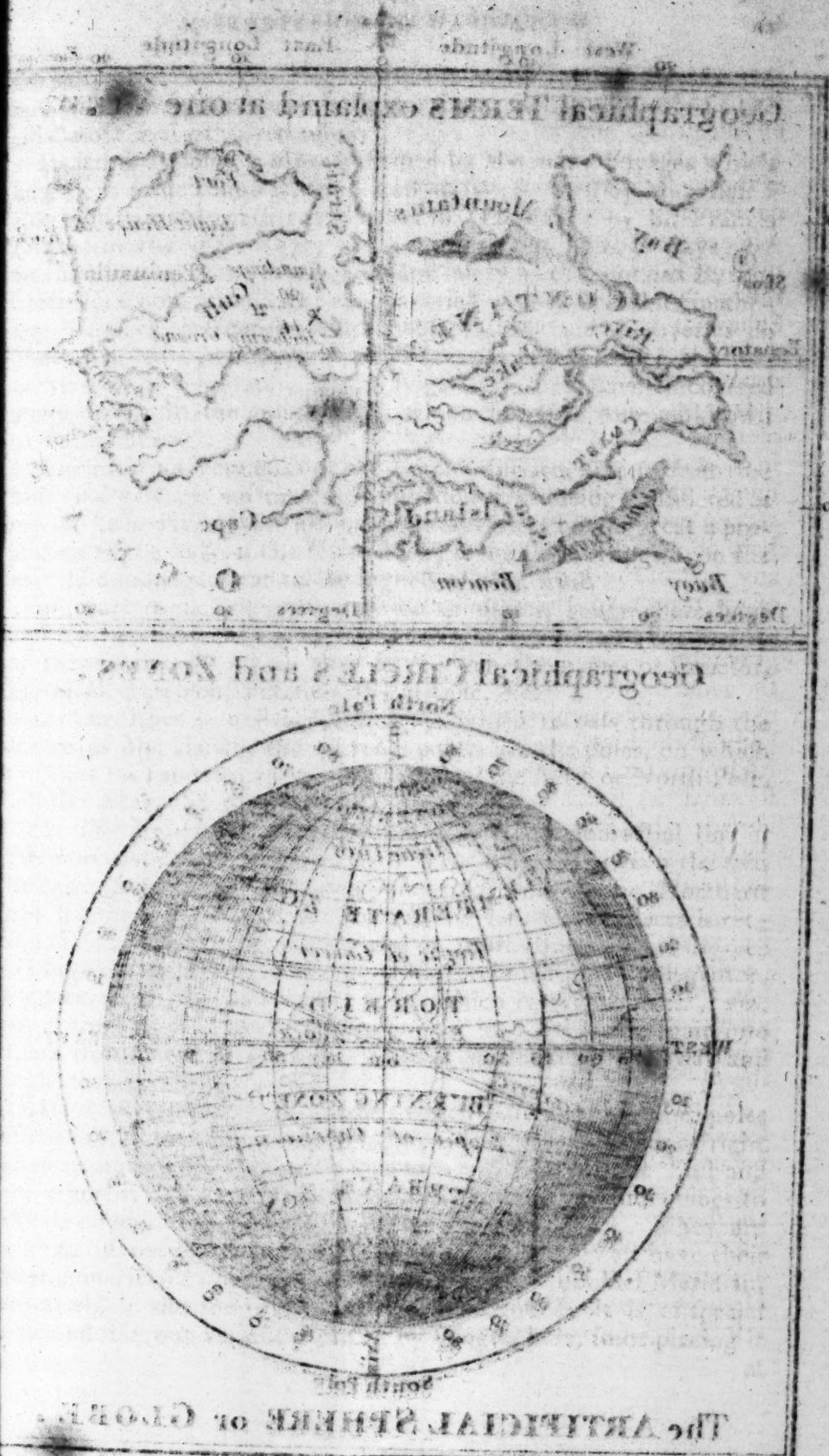
It is demonstrated by the writers of mechanics, that the times of the periodical vibrations of all pendulums of equal lengths, are in a certain proportion to the gravity by which they are acted upon; and it has also been demonstrated, that gravity acts in a certain proportion to the distance from its centre. Hence, by the help of pendulums, we may find the proportion of gravity upon any part of the Earth; and consequently, the proportional distance of that part to the distance of any other part from the Earth's centre. Now, it has been found by experience, that the degree of gravitation upon the Earth's surface under the Equinoctial, is to the same in any Parallel of Latitude, in the same proportion (as near as observation could be made) that it would be, if the whole body of the Earth was composed of a fluid substance, and so formed itself into such a figure, as abovementioned. Hence, we may infer, that the Earth is a Spheroid; and its greatest diameter (which is under the Equinoctial) is computed to be to the lesser diameter, (which is under the Poles, or the Earth's axis) as 289 to 288; and consequently, the space upon the Earth's surface, answering to a degree of a great circle where it is greatest, (or under the Equinoctial) is to the space answering to a degree near the Poles, (where it is least) as 289 to 288; or as a 1000 to 996,5 nearly: but this difference is so small, that in all astronomical and geographical cases, the figure of the Earth may be esteemed truly spherical, though the small difference from it does sensibly affect the motions of pendulums.

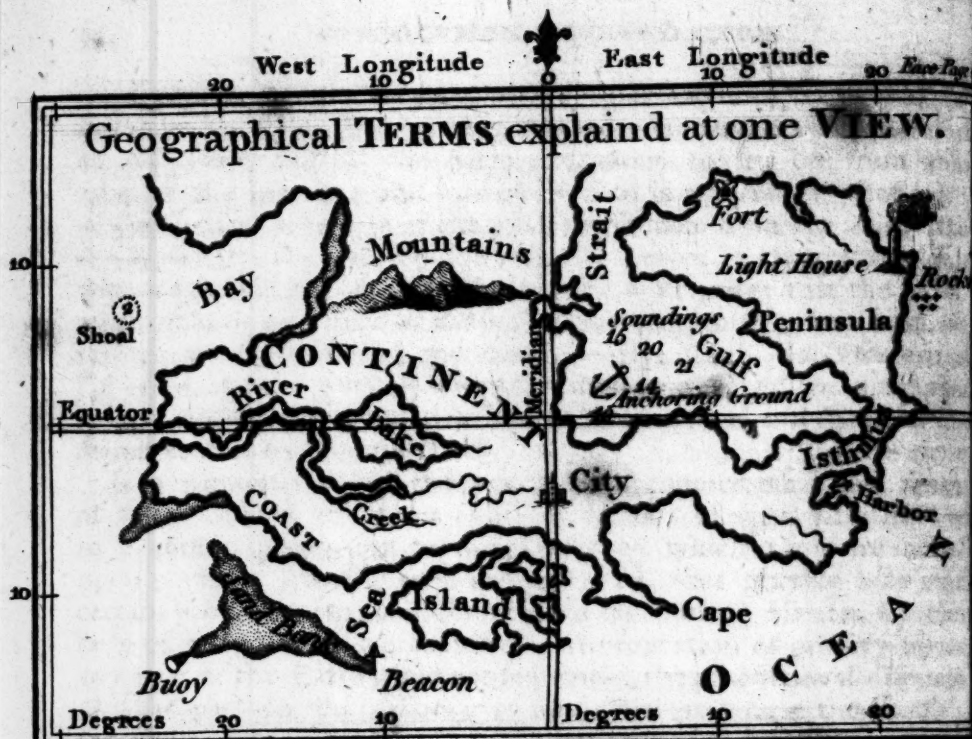
That the Earth is round, or nearly so, will appear, not only from the circular shadow it has upon the Moon, when that body happens to be eclipsed by it, but also from the very appearance of the Sea, and the many observations made by persons standing upon the shore, and viewing a ship departing from the port: they first lose sight of the body of the vessel, whilst they can still see the rigging and uppermost sails; but as the ship recedes farther, they lose sight of these also, as if the whole were sunk in the deep. Again, in a ship making towards land, the mariners first descry the tops of steeples,

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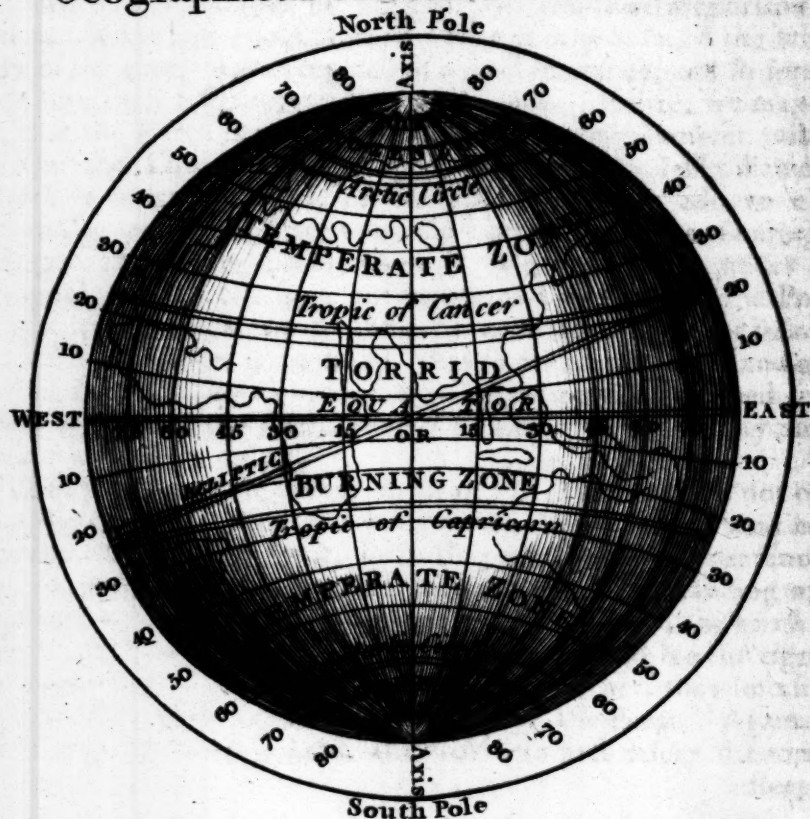
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### Geographical CIRCLES and ZONES.



### The ARTIFICIAL SPHERE or GLOBE.



steeples, trees, &c. pointing above the water; next, they see the buildings themselves; and lastly the shore, which can only be the effects of the Earth's rotundity.

Its being a globe, is also confirmed by the many voyages which have been made round it, from East to West: first by Magellan's ship in the years 1519, 1520, 1521, in 1124 days; by Sir Francis Drake, in the years 1577, 1578, 1579, 1580, in 1056 days; by the late Lord Anson, in 4 years; and lately by the captains Byron, Carteret, Cook, and Clark, accompanied with several able mathematicians and naturalists, whose observations and discoveries do honour to this nation, as well as greatly contribute to the improvement of Geography and Navigation: they have discovered many islands in the South Seas, which formerly were unknown to Europeans.

The little unevennesses of the Earth's surface, arising from the hills and vales, is no material objection to its being considered as round; since the highest hill or mountain bears not so great a proportion to the bulk of the Earth itself, as the little risings upon the coat of an orange, bear to the bigness of that fruit.

In order to describe the position of places, geographers have found it necessary to imagine certain circles drawn upon the surface of the Earth; to which they have given the names of Equator, Meridian, Horizon, Parallels of Latitude, &c.

I. The Axis is a straight line, imagined to pass through the centre of the Earth; the extreme points are the poles, on which the Earth is supposed to move, one called the Artic or North Pole, and the other, the Antartic, or South Pole.

II. The Equator is a great circle under the Equinoctial line in the Heavens, compassing the Earth in the middle, between the two Poles, and divides it into two equal parts, called the Northern and Southern Hemispheres: from it the latitude of places is reckoned either North or South; and on it are counted the degrees of longitude from East to West. This circle is called the Equator, because when the Sun comes to it, which is twice a year, viz, about the 21st of March, at his entrance into Aries, and again into Libra about the 23d of September, then, making equal day and night throughout the world.

III. The Meridians are circles which pass through the poles of the Earth, the Zenith and Nadir; crossing the Equator at right angles, and divide the Earth into two equal parts, one East and the other West; and is so called, because when the Sun comes to the meridian of any place, it is then noon or mid-day. They are infinite in number, for all places from East to West have their several meridians; of these one is called the first or chief Meridian, from which the longitude of places is reckoned; it is of special note and use, but variously placed by geographers, some placing it  
at

at London, others at Paris, Teneriffe, &c. and is divided into twice 90 degrees, numbered from the Equator towards each Pole, ending in 90 degrees, and since the Earth turns once round its axis in 24 hours, every point upon its surface describing a circle of 360 degrees in that time; therefore, any place lying 15 degrees to the East of us, has the Sun upon its meridian one hour sooner; or it is twelve o'clock with the eastermost, when it is eleven with us, and any place 15 degrees to the westward of us, has the Sun one hour after us.

IV. Latitude is the nearest distance of any place from the Equator; it is measured on an arch of the meridian, intercepted between the place and the Equator, and therefore can never exceed 90 degrees. It takes its name according as the place is situated, either North or South of the Equator; therefore, all places that lie at the same distance from, and on the same side of the Equator, are said to be under the same parallel of Latitude. Whence it follows, that if a ship sails from a North Latitude directly North, or in a South Latitude directly South, she encreases her Latitude equal to the distance sailed; and if a ship sails in North Latitude southerly, or in South Latitude northerly, she decreases her Latitude, because she sails nearer the Equator, from whence the Latitude is counted upon the Meridian: but if a ship sails from a South Latitude into a northerly one, or from a North Latitude into a southerly one, from the difference of Latitude subtract the Latitude left, and the remainder will be the Latitude come to, and of a different name with the Latitude left.

Parallels of Latitude are circles parallel to the equator.

The difference of Latitude is an arch of the meridian contained between the two Parallels of Latitude; or it is the least distance of the Parallels of Latitude of two places: shewing how far one of them is to the northward or southward of the other, and can never exceed 180 degrees.

V. The Longitude of any place on the earth is expressed by an arch of the equator, shewing the east or west distance of the meridian of that place, from some fixed meridian, where longitude is reckoned to begin.

Difference of Longitude is an arch of the Equator, intercepted between the meridians of two places, shewing how far one of them is to the eastward or westward of the other.

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NOTE. Here the Teacher will perhaps find it convenient to have a Globe, or Map of the World before him, whereon he can point out the several Positions, Latitudes, Longitudes, &c. to the Pupil, as that will strengthen his memory, and give him a better idea than he can possibly have by only reading them over. The same may be observed in reading the use of Gunter's Scale and the Quadrant.

As

As Longitude begins at the meridian of some place, and is counted from thence both eastward and westward, till it meets at the same meridian on the opposite point, therefore the difference of Longitude can never exceed 180 degrees.

VI. The Horizon, is that apparent circle which limits or bounds the view of a spectator on the sea, or an extended plain; the eye of the spectator being always supposed the centre of his horizon. Every part of this circle is 90 degrees from the centre of it over our heads, which point is called the Zenith; and the point of the Heavens opposite to it, or under our feet, is called the Nadir.

When the sun or stars come above the easternmost part of the Horizon, they are said to rise; and when they descend the western part they are said to set.

When a ship is under the Equator, both the poles appear in the Horizon, and, in proportion as she sails towards either, or increases her latitude, that pole is seen proportionably above the Horizon, and the other disappears as much; but when a ship is sailing towards the Equator, or decreases her latitude, she depresses the elevated pole; that is, its distance from the Horizon decreases: consequently, the latitude of a place is always equal to the elevation of the pole above the Horizon.

This circle is represented by the Mariner's Compass, divided into 32 points or rhumbs, each  $11^{\circ} 15'$ .

The Tropics are two circles parallel to the Equator, and distant from it 23 degrees 29 minutes; that on the north side of it is called the Tropic of Cancer, at which the Sun has its greatest north declination; then making to us, and all places in north latitude, the longest day and shortest night, which is about the 21st of June. The other on the south side is called the Tropic of Capricorn, at which the sun has its greatest south declination, making then our shortest day and longest night, which is about the 22d of December.

The Polar Circles are also parallel to the Equator, compassing the poles of the world at 23 degrees 29 minutes distance; that about the North Pole is called the Arctic Circle, and the other is called the Antarctic Circle.

These Tropics and Polar Circles divide the globe of the earth into 5 parts, called Zones, of which 3 were accounted by the Ancients to be so intemperate as to be uninhabitable; the Zones are called Torrid, Frigid, and Temperate; that is, 1 Torrid or Burning Zone, 2 Temperate, and 2 Frigid or Frozen Zones.

The Torrid Zone, is all that space of the earth and sea which lies between the Tropics of Cancer and Capricorn, and is 47 degrees broad; its inhabitants see the shadow of the sun turn sometimes towards one pole, and sometimes towards the other.

The



The two Temperate Zones are those spaces of the earth and sea contained between each Tropic and the Polar Circles; the inhabitants of the North Temperate Zone have their shadows at noon fall north, and those of the South Temperate Zone have their shadows at noon fall south.

The two Frigid Zones are contained between each Polar Circle and its pole; those who inhabit them have their shadow always running round them, according to the different motions of the sun.

Climates are those tracks of the earth bounded by imaginary lines running parallel to the Equator, and of such a breadth from south to north, that the length of the artificial day in one surpasses that in the other by half an hour.

The inhabitants of the earth are distinguished by the several meridians and parallels under which they live, and are denominated either Periæci, Antiæci, or Antipodes.

The Periæci are those people of the earth who live under the same parallels, but opposite meridians.

The Antiæci are those people of the earth who live under the same meridians, but opposite parallels.

The Antipodes are situated directly opposite to each other, the feet of the one directly against the feet of the other, lying under opposite parallels and opposite meridians. It is midnight with one when it is noon day with the other; the longest day with the one is the shortest with the other; the length of the day with the one is equal to the other's night; and the seasons are opposite; being summer with the one when it is winter with the other.

The Real Parts are earth and water, generally divided into four parts or quarters, called Europe, Asia, Africa, and America; each of these, and consequently the whole globe, is divided into continents, islands, seas, &c.

A Continent is a great quantity of land not divided by the sea, wherein are several empires, kingdoms, and countries conjoined, as Europe, Asia, and Africa, is one Continent, and America another.

An island is a part of the earth that is environed or encompassed round by the sea, as Great Britain and Ireland.

A Peninsula is a part of land almost surrounded with water, save one narrow neck of land which joins the same to the Continent.

An Isthmus is a narrow neck of land joining the Peninsula to the Continent, by which the people may pass from one to the other.

A Promontory is a high part of land, stretching itself into the sea, the extremity of which is called a Cape or Headland.

A Mountain is a rising part of dry land over-topping the adjacent country, and appearing first at a distance.

The earth being encompassed with water, whose washings, in surrounding the dry land, cut and shape many winding bays, creeks, and

and meandering inlets, and extending itself round them all, is but one continued ocean.

An Ocean, is a vast collection of salt water, separating Continents from one another, and washing their borders or shores.

A Sea is part of the Ocean, to which we must sail through some Strait, as the Mediterranean and Baltic Seas.

A Strait is a narrow part of the Ocean lying between two shores, and opening a way into some sea, as the Straits of Gibraltar that lead into the Mediterranean Sea, and the Sound which leads into the Baltic Sea.

A Creek, is a small narrow part of the sea or river, that goes up but a little way into the land.

A Bay, is a great inlet of the land, as the Bay of Biscay, and the Bay of Mexico ; otherwise a Bay is a station or road for ships to anchor in.

A River, is a considerable stream of water issuing out of one or various springs, and continually gliding along in one or more channels, till it discharges itself into the Ocean : The lesser streams are called rivulets.

A Lake is that which continually retains and keeps water in it, as the Lake Zair, in Africa, and Nicaragua, in America.

A Gulph, is a part of the Ocean or Sea, contained between two shores, and is every where environed by land, except its entrance, where it communicates with other bays, seas, or oceans.

There are five oceans, namely, the Northern, the Atlantic, the Pacific, the Indian, and the Southern.

The Atlantic Ocean is usually divided into two parts, one called the North Atlantic Ocean, and the other the South Atlantic, or Ethiopic Ocean.

The Northern Ocean stretches to the northward of Europe, Asia, and American, towards the north pole.

The Atlantic Ocean lies between the Continents of Europe and Africa, on the east, and America on the west.

That part of the North Atlantic Ocean lying between Europe and America, is frequently called the Western Ocean.

The Pacific Ocean, or, as it is sometimes called, the South Sea, is bounded by the western and north-west shores of America, and by the eastern and north-east shores of Asia.

The Indian Ocean washes the shores of the Eastern Coasts of Africa, and the south of Asia, and is bounded on the east by the Indian islands and the Southern Continent.

The Southern Ocean extends to the southward of Africa and America towards the South Pole.

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# NAVIGATION.

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**T**HE great end and business of Navigation is to instruct the Mariner how to conduct a ship through the wide and pathless ocean, to the remotest parts of the world, the safest and shortest way, in passages navigable.

For the due and regular performance of which are requisite—a perfect knowledge of the figure and motion of the earth, the various real and imaginary lines upon it, so as to be able to ascertain the real distance and situation of places with respect to one another, with the use of the several instruments made use of in measuring the ship's way; such as the log, half-minute glass, quadrant, to take the altitude of the sun and stars; compass, to represent the sensible horizon; and azimuth compass, to take the azimuth or amplitude of the sun, in order to know the variation of the magnetic needle; maps or charts of the seas and lands together with the depth of water, the times and settings of the tides upon the coasts he may have occasion to approach near; a competent knowledge of currents; of the mould and trim of the ship, and the sail she bears, that so due allowance may be made for leeway: By help of these, and skill in the Navigator, he may know at all times the place the ship is in, which way he must steer, and how far, to gain his intended port.

Notwithstanding what has been said, it may not be improper here to observe, that,

As latitude is counted from the Equator upon an arch of the meridian, north and south, the difference of latitude between two places, both north or both south, is found by subtracting the less latitude from the greater; but if one latitude be north and the other south, the difference is found by adding both latitudes together.

Consequently, if a ship in north latitude sails northerly, or in south latitude southerly, she encreases her latitude; but in north latitude sailing southerly, or in south latitude sailing northerly, she decreases her latitude; because she sails nearer to the Equator, from whence the latitude is reckoned.

Wherefore in north latitude sailing northerly, or in south latitude sailing southerly, the difference of latitude added to the latitude left, gives the latitude in.

In north latitude sailing southerly, or in south latitude sailing northerly, the difference of latitude subtracted from the latitude left, gives the latitude in.

When



When the latitude decreases, and the difference of latitude is greater than the latitude sailed from, subtract the latitude left from the difference, and the remainder will be the latitude in, and of a different name; for it is plain, in this case, that the ship has crossed the Equator.

As the longitude is counted from the first meridian east and west, until it comes to the opposite meridian, therefore it cannot exceed 180 degrees.

The difference of longitude between two places, being both east or west, is found by subtracting the less longitude from the greater: but if one be in east longitude and the other in west, their sum is the difference of longitude.

Therefore in east longitude sailing easterly, or in west longitude sailing westerly, the difference of longitude added to the longitude left, gives the longitude in.

In east longitude sailing westerly, or in west longitude sailing easterly, the difference of longitude subtracted from the longitude left, gives the longitude in.

When a ship sails east or west, until she passes the opposite meridian, or 180 degrees, she changes her longitude, or comes into a longitude of a different name.

What has been said, will be rendered familiar to the learner by the following examples:

EXAM. I. What is the difference of latitude between London in latitude  $51^{\circ} 32' N.$  and Rome in latitude  $41^{\circ} 54' N.$ ?

|                        |              |
|------------------------|--------------|
| From London's lat.     | $51 : 32 N.$ |
| Subtract Rome's lat.   | $41 : 54 N.$ |
| Rem. the diff. of lat. | $9 : 38 N.$  |
|                        | 60           |
| Diff. in miles         | 578          |

EXAM. III. Required the difference of latitude between Cape Finisterre and Cape Rogue in South America?

|                        |              |
|------------------------|--------------|
| Cape Finisterre's lat. | $42 : 52 N.$ |
| Cape Rogue's lat.      | $5 : 0 S.$   |
| Diff. of lat.          | $47 : 52$    |
|                        | 60           |
| Diff. in miles         | 2872         |

G 2

EXAM. II. A ship from latitude  $29^{\circ} 17' S.$  sails southward until her difference of latitude be 374 miles, what latitude is she come to?

|                               |              |
|-------------------------------|--------------|
| Latitude sailed from          | $29 : 17 S.$ |
| Diff. of lat. $374 \div 60 =$ | $6 : 14 S.$  |
| Lat. in                       | $35 : 31 S.$ |

EXAM. IV. A ship from latitude  $8^{\circ} 25' N.$  sails south 600 miles, what latitude is she in?

|                                  |              |
|----------------------------------|--------------|
| From diff. of lat. 600 miles, or | $10 : 00 S.$ |
| Sub. lat. left                   | $8 : 25 N.$  |
| Diff. lat. in                    | $1 : 35 S.$  |

In

In the last example it is plain, that as the difference of latitude is more than the latitude left, the ship must have crossed the Equator, and consequently come into south latitude.

NOTE. When one of the places has no latitude, or is on the Equator, then the latitude of the other place is their difference of latitude.

EXAM. V. What is the difference of longitude between Cape Finisterre and east point of Barbadoes?

|                         |           |
|-------------------------|-----------|
| Cape Finisterre's long. | 9 : 14W.  |
| Barbadoes' long.        | 59 : 37W. |
| Diff. of long.          | 50 : 23W. |
|                         | 60        |
| Diff. in miles          | 3023      |

EXAM. VII. What is the difference of longitude between Barcelona and Lisbon?

|                   |           |
|-------------------|-----------|
| Barcelona's long. | 2 : 19 E. |
| Lisbon's long.    | 9 : 7W.   |
| Diff. of long.    | 11 : 26W. |

EXAM. IX. What is the difference of longitude between the N. E. point of Japan and St. Christopher's?

|                        |             |
|------------------------|-------------|
| N. E. of Japan's long. | 140 : 25 E. |
| St. Christoher's long. | 62 : 42W.   |
| Exceeds 180° 00'       | 203 : 07    |
|                        | 360 : 00    |
| Diff. of long.         | 156 : 53    |

EXAM. VI. A ship from Cape Charles in Virginia sails westward, till her difference of longitude be 400 miles, what longitude is she in?

|                          |            |
|--------------------------|------------|
| Cape Charles's long.     | 75 : 50W.  |
| Diff. of long. 400 miles | = 6 : 40W. |
| Long. in                 | 82 : 30W.  |

EXAMP. VIII. A ship from 15° 40' E. long. sails westward till her diff. of long. be 27° 15', what long. is she in?

|                |            |
|----------------|------------|
| Long. left     | 15 : 40 E. |
| Diff. of long. | 27 : 15W.  |
| Long. in       | 11 : 35W.  |

EXAM. X. A ship from longitude 160° 20' W. sails westward until she differs her long. 41° 20', what long. is she in?

|                |            |
|----------------|------------|
| Long. left     | 160 : 20W. |
| Diff. of long. | 41 : 20W.  |
|                | 201 : 40   |
|                | 360 : 00   |
| Long. in       | 158 : 20E. |

Here it is plain, that the ship has crossed the opposite meridian, and therefore has come into a longitude of a different name.

In sailing due north or south, the ship changes her latitude only; and sailing east or west her longitude; but sailing upon any other course, she must change both latitude and longitude.

Easting or westing in Plane Sailing is called Departure or Meridian Distance.

The

The instrument used in measuring a ship's way at sea, is the Log.

Ships at sea are directed from one place to another by means of an instrument called the Mariner's Compass.

The Mariner's Compass is an artificial representation of the horizon of every place, by the means of a circular piece of paper, called a card, divided like the horizon into degrees and points, which are called Rhumbs. Now the card being properly fixed to a piece of steel, called the Needle, that has been touched with a loadstone (whose property is such as to cause one end of the needle so touched to point towards the north, when turning freely on something supporting it) all the points of the card will be directed towards the corresponding points of the horizon :

Hence it follows, that in every place the north point of the card shews the position of the meridian of that place, and some one rhumb or point of the card will coincide with, or be directed along the track that makes any given angle with the meridian ; consequently, by the help of the card or compass, a ship may be kept in any proposed track or course.

A Rhumb Line, or point, is a right line drawn from the centre of the compass to the horizon, and is named from that point of the horizon it falls in with.

The Course is the angle which any rhumb line makes with the meridian, and is sometimes reckoned in degrees, and sometimes in points of the compass ; so that if a ship sails upon the second rhumb, or N. N. E. the course is 22 degrees 30 minutes : and so for any other, as in the following table, which the learner should be so well acquainted with, or the compass, as to be able readily to tell how many points any course or rhumb is distant from the meridian, or from the parallel.

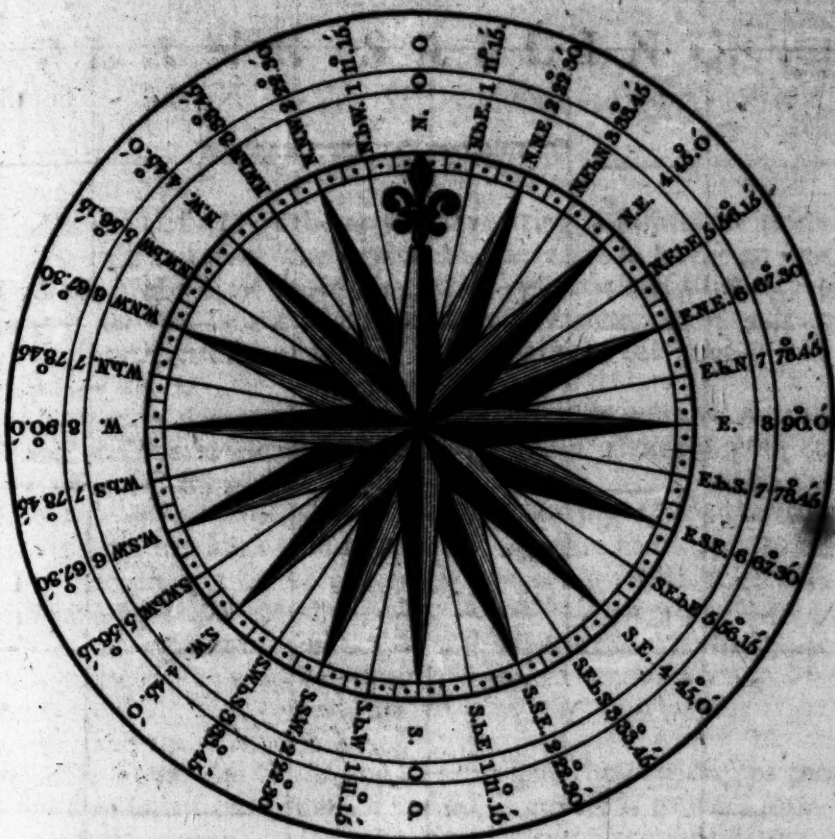
*A Table*



*A Table of the Angles which every Point of the Compass makes with the Meridian.*

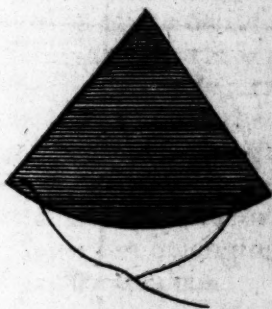
| North.   | South.   | Points.       | D. M. | North.      | South.    |
|----------|----------|---------------|-------|-------------|-----------|
|          |          | $\frac{1}{4}$ | 2.49  |             |           |
|          |          | $\frac{1}{2}$ | 5.37  |             |           |
|          |          | $\frac{3}{4}$ | 8.26  |             |           |
| N. by E. | S. by E. | 1             | 11.15 | N. by W.    | S. by W.  |
|          |          | $\frac{1}{4}$ | 14.4  |             |           |
|          |          | $\frac{1}{2}$ | 16.52 |             |           |
|          |          | $\frac{3}{4}$ | 19.41 |             |           |
| N. N. E. | S. S. E. | 2             | 22.30 | N. N. W.    | S. S. W.  |
|          |          | $\frac{1}{4}$ | 25.19 |             |           |
|          |          | $\frac{1}{2}$ | 28.7  |             |           |
|          |          | $\frac{3}{4}$ | 30.56 |             |           |
| NE by N  | SE by S. | 3             | 33.45 | N. W. by N. | S.W. by S |
|          |          | $\frac{1}{4}$ | 36.34 |             |           |
|          |          | $\frac{1}{2}$ | 39.22 |             |           |
|          |          | $\frac{3}{4}$ | 42.11 |             |           |
| N. E.    | S. E.    | 4             | 45.0  | N. W.       | S. W.     |
|          |          | $\frac{1}{4}$ | 47.49 |             |           |
|          |          | $\frac{1}{2}$ | 50.37 |             |           |
|          |          | $\frac{3}{4}$ | 53.26 |             |           |
| NE by E  | SE by E. | 5             | 56.15 | N. W. by W. | SW by W   |
|          |          | $\frac{1}{4}$ | 59.4  |             |           |
|          |          | $\frac{1}{2}$ | 61.52 |             |           |
|          |          | $\frac{3}{4}$ | 64.42 |             |           |
| E. N. E. | E. S. E. | 6             | 67.30 | W. N. W.    | W. S. W.  |
|          |          | $\frac{1}{4}$ | 70.19 |             |           |
|          |          | $\frac{1}{2}$ | 73.7  |             |           |
|          |          | $\frac{3}{4}$ | 75.56 |             |           |
| E. by N. | E. by S. | 7             | 78.45 | W. by N.    | W. by S.  |
|          |          | $\frac{1}{4}$ | 81.34 |             |           |
|          |          | $\frac{1}{2}$ | 84.22 |             |           |
|          |          | $\frac{3}{4}$ | 87.11 |             |           |
|          | Eaft.    | 8             | 90.0  | West.       |           |

# THE MARINERS COMPASS.

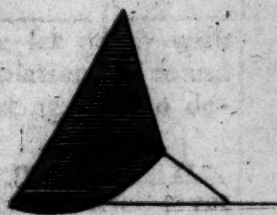


## HALF MINUTE GLASS.

The Log

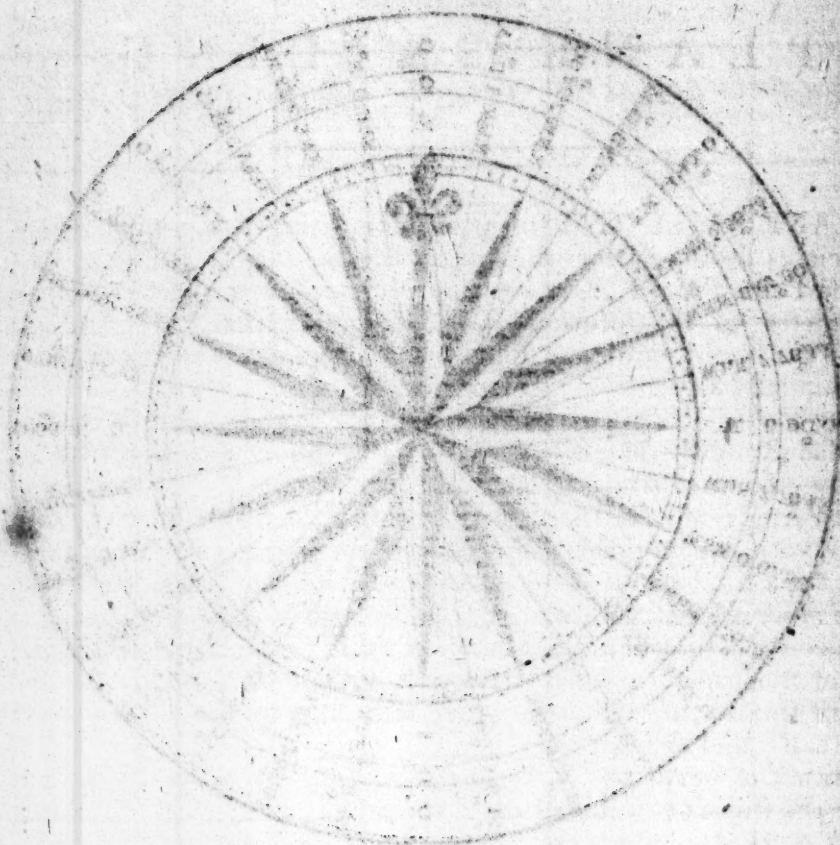


The Log  
in the Act of heaving



*N.B. There are many kinds of Logs, but the above is the most Common.*

# THE MARINER'S COMPASS



## THE VESSEL'S POSITION



THE VESSEL'S POSITION IS DETERMINED BY THE LIGHTS OF THE COAST

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## PLANE SAILING.

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**PLANE SAILING** is the art of navigating a ship upon principles deduced from the notion of the earth's being an extended Plane; and is no more than the application of Plane Trigonometry to the solution of the several variations, or cases; where the hypotenuse, or longest side, is always the rhumb that the ship sails upon.

The Perpendicular is the difference of latitude counted on the meridian, and the base the departure: which is either easting or westing, counted from the meridian.

The Angle opposite the base is the course, or angle, that the ship makes with the meridian; and the angle opposite the perpendicular is the complement of the course, which being taken together, make always eight points or rhumbs, which is 90 degrees.

In constructing figures relating to a ship's course, let the upper part of the paper, or what the figure is drawn upon, always represent the north; the lower part will be the south; the right hand east; and the left west.

Draw the north and south line to represent the meridian of the place the ship sails from; then, if the ship's course is to the southward, mark the upper end of the line for the place sailed from; but if the course is northward, mark the lower end for that place.

When the course is easterly, describe the arch, and lay off the course and departure on the right-hand side of the meridian; but when westerly on the left-hand side.

When the course is given in degrees, the degrees expressing it must be taken from the line of chords; but when in points from the line of rhumbs; and is always to be laid off upon the arch, beginning at the meridian.

When the course is given in points, it may be set down with its corresponding logarithm in points in the calculation, as found in the first page of the logarithms, without reducing it into degrees, as it seems altogether unnecessary.

In all cases, wherever the complement course, or co-sine, &c. is used, the degrees or points put down is the course itself; yet the logarithm belonging to the complement, or co-sine, &c. of that course is taken.

CASE

## CASE I.

*Course and Distance sailed given, to find the Difference of Latitude and Departure from the Meridian.*

A Ship from the Lizard, in Latitude  $49^{\circ} 57' N$ . sails S. W. by W. 488 Miles.

Required the Latitude she is in, and her Departure from the Meridian she sailed from?

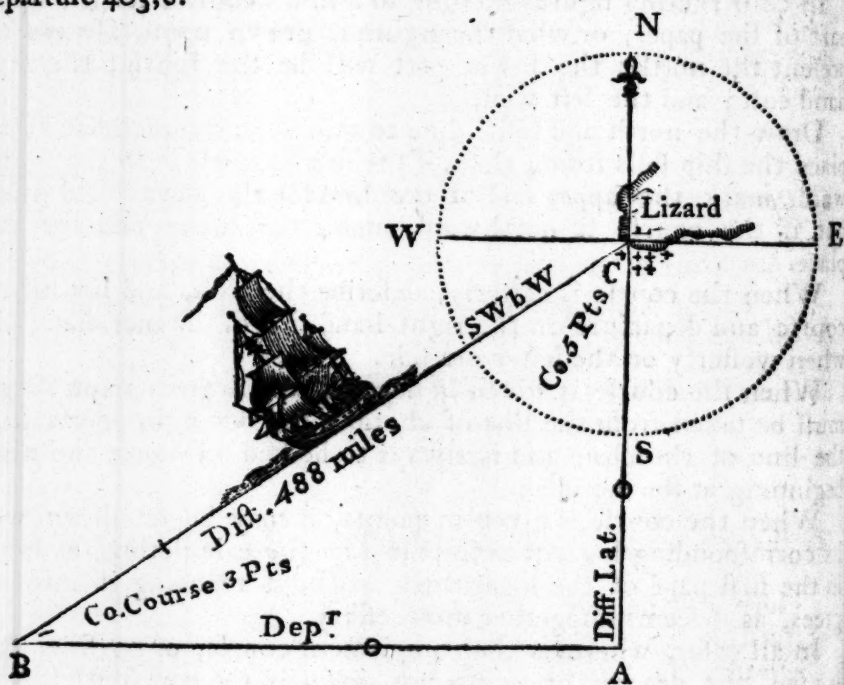
## By CONSTRUCTION.

Draw the Line CA to represent the meridian of the Lizard, and C the Lizard Point.

With the chord of  $60^{\circ}$  in your compasses, and one foot in C, describe the compass N. W. S. E.

Take 5 points in your compasses from the line of rhumbs on the plane scale, and set it off on the arch from S. towards W. for the course; draw the line CB, which make equal to the distance 488; draw BA parallel to the E. and W. points W. E. to cut the Meridian in A.

Then will AC be the difference of latitude 271,1, and AB the departure 405,8.



By making the Distance Radius, it will be by AXIOM I.

| The course 5 points = $56^{\circ} 15'$<br>To find the Departure. |              |          | The co-course 3 points $33^{\circ} 45'$<br>To find the Difference of lat. |              |          |
|------------------------------------------------------------------|--------------|----------|---------------------------------------------------------------------------|--------------|----------|
| As radius                                                        | $90^{\circ}$ | 10.00000 | As radius                                                                 | $90^{\circ}$ | 10.00000 |
| Is to the distance 488                                           |              | 2.68842  | Is to the dist.                                                           | 488          | 2.68842  |
| So is the fine course 5 pts.                                     |              | 9.91985  | So is co-fine course 5 pts.                                               |              | 9.74474  |
|                                                                  |              | <hr/>    |                                                                           |              | <hr/>    |
|                                                                  |              | 12.60827 |                                                                           |              | 12.43316 |
|                                                                  |              | 10.00000 |                                                                           |              | 10.00000 |
|                                                                  |              | <hr/>    |                                                                           |              | <hr/>    |
| To the departure 405,8                                           |              | 2.60827  | To the diff. of lat. $271,1$                                              |              | 2.43316  |

Now as the ship is in north latitude sailing southerly from the latitude left

Take the difference of latitude  $271,1 = 46^{\circ} 57' N.$

Gives the latitude in  $42^{\circ} 26' N.$

And the departure from the Meridian is 405,8 miles.

By making the Departure Radius, it will be,

| To find the Departure.          |  |          | To find the Diff. of Latitude. |  |          |
|---------------------------------|--|----------|--------------------------------|--|----------|
| As co-sec. course 5 pts.        |  | 10.08015 | As co-sec. course 5 pts.       |  | 10.08015 |
| Is to the dist. 488             |  | 2.68842  | Is to the dist. 488            |  | 2.68842  |
| So is radius 8 pts $90^{\circ}$ |  | 10.00000 | So is co-tan. course 5 pts.    |  | 9.82489  |
|                                 |  | <hr/>    |                                |  | <hr/>    |
|                                 |  | 12.68842 |                                |  | 12.51331 |
|                                 |  | 10.08015 |                                |  | 10.08015 |
|                                 |  | <hr/>    |                                |  | <hr/>    |
| To the departure 405,8          |  | 2.60827  | To the diff. of lat. $271,1$   |  | 2.43316  |

By making the Difference of Latitude Radius, it will be,

| To find the Departure.    |  |          | To find the Difference of Latitude.  |  |          |
|---------------------------|--|----------|--------------------------------------|--|----------|
| As sec. course 5 pts.     |  | 10.25526 | As sec. course 5 pts.                |  | 10.25526 |
| Is to the dist. 488       |  | 2.68842  | Is to the dist. 488                  |  | 2.68842  |
| So is tang. course 5 pts. |  | 10.17511 | Is to the radius 8 pts. $90^{\circ}$ |  | 10.00000 |
|                           |  | <hr/>    |                                      |  | <hr/>    |
|                           |  | 12.86353 |                                      |  | 12.68842 |
|                           |  | 10.25526 |                                      |  | 10.25526 |
|                           |  | <hr/>    |                                      |  | <hr/>    |
| To the dep. 405,8         |  | 2.60827  | To the diff. of lat. $271,1$         |  | 2.43316  |

Here all the three sides are made radius, to find the difference of latitude and departure; therefore, the Learner may make which side radius he pleases; but as, for my part, I shall make the first, where the distance is made radius, whenever the course is given.

Though this method of working by logarithms is certain, yet the same may be wrought by Gunter's Scale and Compasses, much  
H more



more expeditiously, and exact enough in the practice of navigation.

**NOTE.**—When the course is given in points, make use of the lines marked fine rhumbs, and tangent rhumbs, on the upper side of the Scale; when in degrees, make use of the lines marked fine and tangent.

#### By G U N T E R.

Now to perform the last case, extend from radius or 8 points to 5 points on the line marked S R; that extent will reach from the distance 488 to the departure 405,8 on the line of numbers.

2dly. 'Extend from radius or 8 points to 3 points (the complement of the course) on the line S R; that extent will reach from the distance 488 to the difference of latitude 271 on the line of numbers.'

Thus may all the operations be performed in the several cases of Navigation.

By this case is calculated the tables of latitude and departure for every degree, point, and quarter-point of the Mariner's Compass, to the distance of 300 miles, which is of excellent use in working days' works at sea, and may be applied both to middle latitude and Mercator's Sailing, as shall be shown hereafter; we shall only proceed now to the working of the last case by the Table of Diff. of Latitude and Departure.

#### By I N S P E C T I O N.

Find the given course at the top or bottom of the tables, either among the points or degrees, and in that page, and right against the distance taken in its column, stand the difference of latitude and departure in their columns.

Thus the course is S. W. by W. or 5 points, which is found at the bottom of the table of difference of latitude and departure for points: and as the distance 488 is too great to be found in the tables, divide it by 2, (or any other convenient number) and that gives 244, which look for in the distance column, and right against it stands 135,5 for the difference of latitude, and 202,8 for the departure, which being doubled, (because divided by 2) gives 271, for the difference of latitude, and 405,6 for the departure, the same as before. Any of these methods will do, but the last is chiefly practised at sea.

#### C A S E II.

*Course and Difference of Latitude given, to find the Distance run, and Departure from the Meridian.*

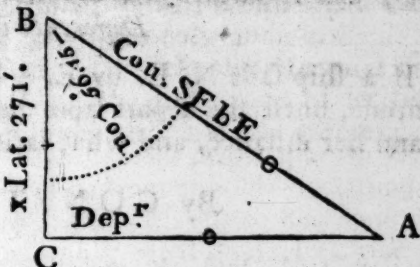
If a ship runs S. E. by E. from  $1^{\circ} 45'$  north latitude, and then by observation is in  $2^{\circ} 46'$  south latitude, what is her distance and departure?

Now,

Now, in this case, as the ship has crossed the Equator, therefore the latitude  $1^{\circ} 45' N.$  added to  $2^{\circ} 46' S.$  is  $4^{\circ} 31'$ , which multiplied by 60 gives 271 miles for the difference of latitude.

Constructed the same as Problem VII. in Geometry.

Draw  $BC=271$ , and  $BA$  making an angle with  $BC = 5$  points, or  $6^{\circ} 15'$ ; upon  $C$  erect the perpendicular  $CA$  to join  $BA$  in  $A$ , and it is done; then will  $CA = 405.6$ , and  $AB = 496$ .



By making the Distance  $AB$  Radius, it will be,

Course S. E. by E. 5 Pts. =  $56^{\circ} 15'$

To find the Departure.

|                             |          |
|-----------------------------|----------|
| As co-fine course 5 pts.    | 9.74474  |
| Is to the diff. of lat. 271 | 2.43297  |
| So is fine course 5 points  | 9.91985  |
|                             | <hr/>    |
|                             | 12.35282 |
|                             | 9.74474  |
|                             | <hr/>    |

To the departure 405.6

Complement 3 Points =  $33^{\circ} 45'$

To find the Distance.

|                             |          |
|-----------------------------|----------|
| As co-fine course 5 pts.    | 9.74474  |
| Is to the diff. of lat. 271 | 2.43297  |
| So is radius                | 10.00000 |
|                             | <hr/>    |
|                             | 12.43297 |
|                             | 9.74474  |
|                             | <hr/>    |

To the distance 487.8

Hence the ship's distance run is 487.8 miles, and her departure from the meridian is 405.6 easterly.

### By G U N T E R.

' Extend from 3 to 5 points on the line marked  $SR$ , that extent will reach from the difference of latitude 271 to the departure 405.6 on the line of numbers.

2dly. ' Extend from radius or 8 points to 3 points, that extent will reach from the difference of latitude 271 to the distance 488 on the line of numbers.'

### By I N S P E C T I O N.

Find the course among the points or degrees, and the difference of latitude in its column, right against which stand the distance and departure in their columns.

Now, as the difference of latitude 271 is too great to be found in the tables, I divide it by 5, and that gives 54, which I find over 5 points in the latitude column; against that stands 98, for the distance, and 81.5 for the departure, which being multiplied by 5 is 490 the distance, and 407.5 the departure nearly, as before.





## By INSPECTION.

Find the course either among the points or degrees, and the departure in its column, right against which stands the distance and difference of latitude in their respective columns.

Thus, with the course  $5\frac{1}{4}$  points, and  $\frac{1}{2}$  the departure, I find 202,5 for the distance, and 95,8 for the difference of latitude, which being doubled, gives the distance 405, and the difference of latitude 191,6, as before.

## CASE IV.

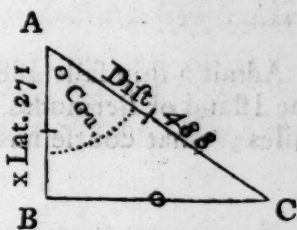
*Distance and Difference of Latitude given, to find the Course and Departure.*

Suppose a ship sails 488 miles, between the South and the East, from a port in  $2^{\circ} 52'$  South Latitude, and then by observation is in  $7^{\circ} 23'$  South Latitude; what course has she steered, and what departure has she made?

From the latitude by observation  $7^{\circ} 23'$  take  $2^{\circ} 48'$  the latitude left, the remainder  $4^{\circ} 35'$  multiply by 60 = 271 miles or minutes of difference of latitude.

Constructed as Problem VIII. in Geometry.

Draw the Meridian  $AB = 271$ ; upon B erect the perpendicular  $BC$ ; take 488 in your compasses, and with one foot on A, lay the other on the line  $BC$ ; join A and C; then will  $BC$  be the departure 406, and the angle  $BAC$  the course =  $56^{\circ} 10'$ , or 5 points nearly.



To find the Course.

|                          |          |
|--------------------------|----------|
| As the distance 488      | 2.68842  |
| Is to radius             | 10.00000 |
| So is the diff. lat. 271 | 2.43297  |
|                          | <hr/>    |
|                          | 12.43297 |
|                          | 2.68842  |
|                          | <hr/>    |

To co-fine cou.  $56^{\circ} 16'$  9.74455

To find the Departure.

|                                    |          |
|------------------------------------|----------|
| As radius                          | 10.00000 |
| Is to the distance 488             | 2.68842  |
| So is fine course $56^{\circ} 16'$ | 9.91993  |
|                                    | <hr/>    |
|                                    | 12.60835 |
|                                    | 10.00000 |
|                                    | <hr/>    |

To the departure 405,8 2.60835

Hence the course is S. E. by E. and the departure 405,8.

By GUNTER.

'The extent, from the distance 488 to the difference of latitude 271 on the line of numbers, will reach from radius or  $90^{\circ}$  to  $33^{\circ} 44'$  the co-course on the line of fines.

'And

' And the extent, from radius to  $56^{\circ} 16'$  on the line of fines, will reach from the distance 488 to the departure 405,8 on the line of numbers.'

### By I N S P E C T I O N.

Seek in the tables till against the distance, taken in its column, be found the given difference of latitude in one of the following columns; and adjoining to it stands the departure; which, if less than the difference of latitude, the course is found at the top; but if greater, the course is found at the bottom.

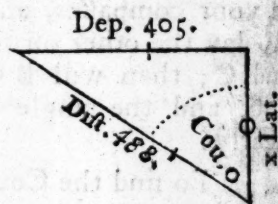
Now, with half the distance 244, and half the difference of latitude 135,5, look in the tables till they are found to agree in their respective columns, which they do nearly over 5 points, against them stands 202,8 for the departure, which being doubled, gives 405,6 nearly, as before.

### C A S E V.

*Distance and Departure given, to find the Course and Difference of Latitude.*

Admit a ship sails 488 minutes between the north and west from the Island of Bermudas in lat.  $32^{\circ} 25'$  north, until her dep. is 405 miles; what course has she steered, and what lat. is she in?

NOTE. This Case is constructed much the same as the last.



| To find the Course. |          | To find the Diff. of Lat.         |          |
|---------------------|----------|-----------------------------------|----------|
| As the distance 488 | 2.68842  | As radius -                       | 10.00000 |
| Is to radius -      | 10.00000 | Is to the distance 488            | 2.68842  |
| So is departure 405 | 2.60746  | So is co-sine co. $56^{\circ} 6'$ | 9.74644  |
|                     | <hr/>    |                                   | <hr/>    |
|                     | 12.60746 |                                   | 12.43486 |
|                     | 2.68842  |                                   | 10.00000 |
|                     | <hr/>    |                                   | <hr/>    |

To the sine of cou.  $56^{\circ} 6'$  9.91904 | To the diff. of lat. 272.2 2.43486

Hence the Course is N.  $56^{\circ} 6'$  W. or N. W. by W

To the latitude failed from  $32^{\circ} 25'$  add the difference of latitude 272, or  $4^{\circ} 32'$ , gives  $36^{\circ} 57'$ , the latitude the ship is in.

By

By G U N T E R.

‘ Extend from the distance 488 to the departure 405 on the line of numbers, that extent will reach from radius to the course  $56^{\circ} 10'$  on the line of fines.’

2dly. ‘ Extend from radius to the complement of the course  $33^{\circ} 50'$  on the line of fines, that extent will reach from the distance 488 to the diff. of lat. 271 on the line of numbers.’

By I N S P E C T I O N,

Seek in the tables till against the distance, taken in its column, be found the given departure in one of the following columns; and adjoining to it stands the difference of latitude; which, if greater than the departure, the course is found at the top; but if less, the course is found at the bottom.

Now, with half the distance 244, and half the departure 203, I look in the tables, and find them to agree in their columns, nearly over 5 points, against which is latitude 135.5, which, being doubled, is 271.6, the difference of latitude nearly as before.

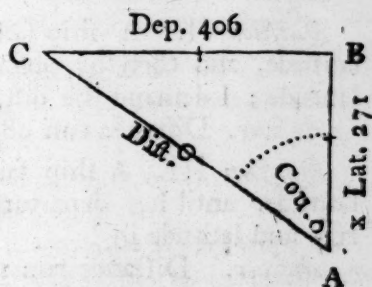
C A S E VI.

*Difference of Latitude and Departure given, to find the Course and Distance.*

A ship sails between the north and west till her difference of latitude is 271 miles, and her departure is 406 miles; I demand her course and distance?

Constructed as Problem IX. in Geometry.

Draw  $AB = 271$ , and perpendicular to it  $BC = 406$ ; join  $C$  and  $A$ ; then will the angle  $CAB$  be the course =  $56^{\circ} 17'$ , and  $AC$  the distance = 488 miles.



To find the Course.

|                          |          |
|--------------------------|----------|
| As the diff. of lat. 271 | 2.43297  |
| Is to radius             | 10.00000 |
| So is the departure 406  | 2.60853  |
|                          | <hr/>    |
|                          | 12.60853 |
|                          | 2.43297  |
|                          | <hr/>    |

To the tang. of the cou.  
 $56^{\circ} 17'$  - - - 10.17556

To find the Distance.

|                             |          |
|-----------------------------|----------|
| As radius                   | 10.00000 |
| Is to the diff. of lat. 271 | 2.43297  |
| So is sec. of the course    |          |
| $56^{\circ} 17'$ - - -      | 10.25564 |
|                             | <hr/>    |
|                             | 12.68861 |
|                             | 10.00000 |
|                             | <hr/>    |

To the distance 488,2 2.68861

Hence her course is N.  $56^{\circ} 17'$  W. and the distance sailed is 488,2 miles.

By



## By GUNTER.

Extend from the difference of latitude 271 to the departure 406 on the line of numbers, that extent will reach from radius to  $56^{\circ} 17'$  the course on the line of tangents.

2dly. For the distance we must consider it as radius (there being no line of secants on the scale), and extend from radius or 90 to the course 5 points on the line of sines, that extent will reach from the departure 406, to the distance 488 on the line of numbers.

## By INSPECTION.

Seek in the tables till half the given difference of latitude 135 and departure 203 are found together in their respective columns; then right against them will be found the distance 244, in its column, and the course stand in degrees either at the top or bottom of the column where the difference of latitude and departure was found, which in this case is under  $56^{\circ} 15'$ , or 5 points the course required.

The six foregoing Problems are the common cases of Plane Sailing which the Learner ought to be well acquainted with; and for the end I here add six more for practice, whose answers may be found by the foregoing rules:

*Question I.* A ship in  $2^{\circ} 10'$  south latitude, sails N. by E. 8 leagues; what latitude is she in, and what is her departure?

*Answer.* Latitude in  $2^{\circ} 12'$  N. and departure 17.36 leagues.

*Question II.* A ship sails S. S. W. from a port in  $41^{\circ} 30'$  north latitude, and then by observation the said ship is in  $36^{\circ} 57'$  north latitude; I demand the distance run and departure?

*Answer.* Distance run 98.5 leagues, departure 37.7 leagues.

*Question III.* A ship sails S. S. W. half W. from  $2^{\circ} 30'$  south latitude, until her departure be 59 leagues; I demand her distance run and latitude in?

*Answer.* Distance run 125.2 leagues, latitude in  $8^{\circ} 1'$  south.

*Question IV.* If a ship sails 360 miles south westward from  $21^{\circ}$  south latitude, until by observation she be in  $24^{\circ} 49'$  south latitude, what is her course and departure?

*Answer.* The course is S. W. half W. and her departure from the meridian is 317.3 miles.

*Question V.* Suppose a ship sails 354 miles north eastward from  $2^{\circ} 9'$  south latitude, until her departure be 150 miles; what is her course and latitude in?

*Answer.* Her course is N.  $25^{\circ} 4'$  E. or N. N. E.  $\frac{1}{4}$  E. nearly, and she is in latitude  $3^{\circ} 12'$  north.

*Que*

*Question VI.* Sailing between the north and the west, from a port in  $1^{\circ} 59'$  south latitude, and then arriving at another port in  $4^{\circ} 8'$  north latitude, which is 200 miles to the westward of the first port, demand the course and distance from the first port to the second?

*Answer.* The course is N.  $29^{\circ} 40'$  W. or N. N. W.  $\frac{3}{4}$  W. nearly; and the distance of the ports is 422,3 miles, or 140,7 leagues.

## TRAVERSE SAILING.

**H**AVING learned those necessary Problems, concerning a Single Course, the next is a Compound Course, commonly called a Traverse; in order to the right understanding of which, observe the following definitions:

A Traverse is when a ship, meeting with contrary winds, sails on several courses.

When the wind is directly or partly against a ship's direct course to the place she is bound to, she reaches her port by a kind of Z like course; which is made by sailing with the wind, first on one side of the ship, and then on the other side.

In a ship, when looking towards the stem or head.

Starboard signifies the right-hand side.

Larboard the left-hand side.

Forwards or Afore, is towards the head or stem of the ship.

Aft or Abaft, is towards the hinder part or stern.

The Beam signifies athwart or across the middle of the ship.

When the ship sails the same way the wind blows, she is said to sail or run before the wind; and the wind is right aft, or right a stern; and her course is then 16 points from the wind.

When a ship sails with the wind blowing directly across her, she is said to have the wind on the beam; and her course is 8 points from the wind.

When the wind blows obliquely across the ship, the wind is said to be abast the beam, or afore the beam, according as her course is more or less than 8 points from the wind.

When a ship endeavours to sail towards that point of the compass from whence the wind blows, she is said to sail on a wind, or to ply to windward.

I

A vessel

A vessel sailing as near as she can to the point from whence the wind blows, is said to be close hauled. The generality of ships will lie within about 6 points of the wind, but sloops and other vessels will lie much nearer.

The Windward or Weather-side, is that side of the ship on which the wind blows; and the other side is called the Leeward or Lee-side.

Tacks and Sheets are large ropes made fast to the lower corners of the fore and main-sails, by which either of these corners are hauled fore and aft.

When a ship sails on the wind, the windward tacks are always hauled forwards, and the leeward, or lee-sheets, aft.

The starboard tacks are aboard when the starboard side is to windward, and the larboard to leeward; and the larboard tacks are aboard when the larboard side is to windward, and the starboard to leeward.

To know how near the wind a ship will lie, observe the course she goes on each tack when she is close hauled, then half the number of points between the two courses will shew how near the wind that ship will lie.

The most common cases, in turning to the windward, may be constructed by the following precepts:

Having drawn the meridian, or north and south, and parallel of latitude (or east and west line) in a circle, representing the horizon of the place, mark, in the circumference, the place of the wind; draw the rhumb, passing through the place bound to, and lay thereon the distance of that place from the centre.

On each side of the wind lay off in the circumference the points or degrees shewing how near the wind the ship can lie, and draw the rhumbs.

Now the first course will be on one of those rhumbs, according to the tack the ship leads with; draw a line through the place bound to, parallel to the other point, to meet with the first, and this will shew the course and distance on the other tack.

To resolve a Traverse, is to reduce and bring several courses into one; the courses are known by the compass, and the distance by the log, which in common voyages is hove once in two hours, but in ships of war, or in East-Indiamen, every hour.

In the steerage, or some convenient place in the ship, there is generally kept a table, called the log-board, divided into seven columns; in the first is written the hours of the day, in the second the knots that the ship runs during half a minute; each of these knots bear the same proportion to a sea mile that half a minute does to an hour; consequently so many knots as the ship runs in half a minute, (the time allowed for trying the experiment) so many miles she runs in an hour. In the third the fathoms, 10 of which ought to make a knot; in the fourth, the courses steered by



by the compass; in the fifth the winds; in the sixth the leeway, or how far the ship is drove to the leeward of the course steered by the compass; in the seventh the transactions of the day, as in the following table. Every day at noon the contents are transcribed into the log-book, which is divided into columns, exactly like the log-board, and the several courses being corrected by allowing for the leeway and variations, and the distance run upon each being set down in a traverse table, shews what difference of latitude and departure the ship has made during the last 24 hours; and from thence is found the latitude and longitude the ship is in, &c. This operation is called doing a day's work.

## THE LOG-BOARD.

| H. | K. | F. | Courses.    | Winds.   | Lee-way. | Transactions.     |
|----|----|----|-------------|----------|----------|-------------------|
| 2  | 6  |    | S. W. by S. | N.       |          |                   |
| 4  | 5  | 5  |             | N. W.    |          |                   |
| 6  | 5  |    |             |          |          |                   |
| 8  | 5  |    |             |          |          |                   |
| 10 | 4  | 5  | N. E.       | N. W. W. |          | Moderate gales    |
| 12 | 4  | 5  |             |          |          | and fair weather; |
| 2  | 4  | 5  |             |          |          | at 8 A. M. saw    |
| 4  | 4  | 5  |             |          |          | a ship to the     |
| 6  | 4  | 5  |             |          |          | northward.        |
| 8  | 5  |    | S. W. by S. | W. N. W. |          |                   |
| 10 | 4  | 5  |             |          |          | No observa-       |
| 12 | 4  |    |             |          |          | tion.             |

Having placed the several courses, and distances run upon each, begin with the first course S. W. by S. which is 3 points, and the distance run upon it being summed up, is 21,5 or an half, which being doubled (because the log is hove every two hours) is 43. In like manner proceed with the other courses, and then find the difference of latitude and departure for each course and distance.

When the course is to the southward, the difference of latitude must be set in the column marked S. but if to the northward,

in that marked N. ; likewise when the course is to the eastward, the departure must be set in the column marked E. ; but if to the westward, in that marked W. Thus the first course being S. W. by S. 3 points, the difference of latitude belonging to it is set under S. and the departure under W. as in the following table :

THE TRAVERSE TABLE.

| Courses.    | Dist. | N.            | S.           | E.      | W.           |
|-------------|-------|---------------|--------------|---------|--------------|
| S. W. by S. | 43    |               | 35,8         |         | 23,9         |
| N. E.       | 45    | 31,8          |              | 31,8    |              |
| S. W. by W. | 27    |               | 22,4         |         | 15,0         |
|             |       | 31,8          | 58,2<br>31,8 | 31,8    | 38,9<br>31,8 |
|             |       | D. Lat.<br>S. | 26,4         | Dep. W. | 7,1          |

Here the westings being greater than the easting, the difference shews how far the ship has got to the westward ; and the southings being greater than the northing, shew how far she has got to the southward of the place she set out from.

Now the difference of latitude 26,4 and departure 7,1 being looked for in the tables, will be found nearly standing together under  $15^{\circ}$  and against distance 27. Hence the course made good upon the several courses is S.  $15^{\circ}$  W. and the distance 27 miles.

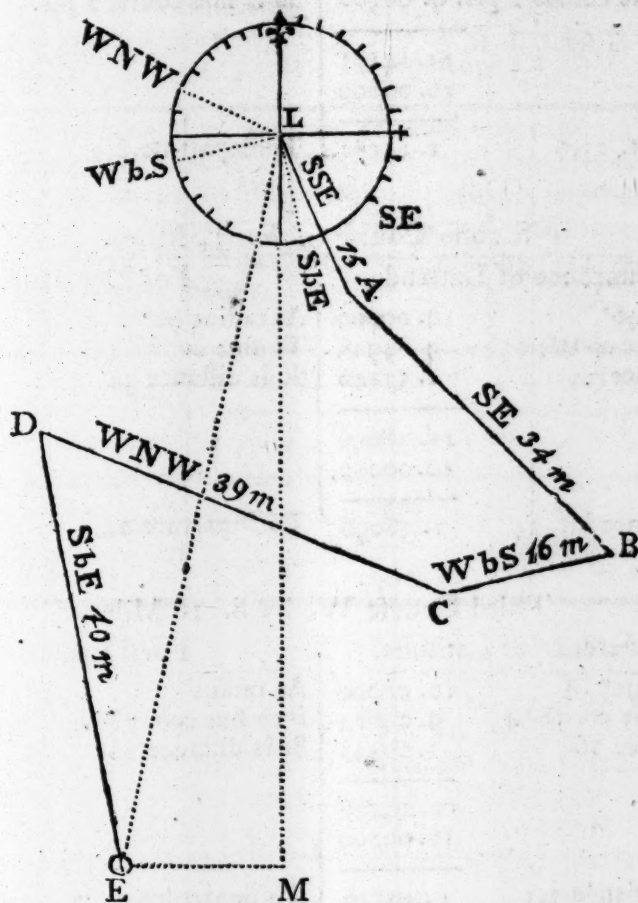
In heaving the log, one man holds the reel upon which the log-line is wound, and another holds the half-minute glass; an officer of the watch heaves the log over on the lee-quarter, and when he observes the stray-line is run off the reel (to denote which there is fixed a red rag) he cries *turn!* the glass-holder answers *done!* who, watching the glass, the moment it is run out, cries *stop!* the reel being immediately stopped, the knots, or knots and fathoms run off, shew the ship's rate of sailing per hour, if the wind happens to have been constant.

EXAMPLE

## EXAMPLE I.

Suppose a ship takes her departure from the Lizard in latitude  $49^{\circ} 57' N$ . it bearing then N. N. W. distance by estimation 5 leagues, sails S. E. 34, W. by S. 16, W. N. W. 39, and S. by E. 40 miles; required the latitude she is in and her bearing and distance from the Lizard?

By CONSTRUCTION.



Draw the line  $LM$  to represent the meridian of the Lizard, and  $L$  the Lizard point; on  $L$  describe the compass; then set off the opposite point to the bearing of the Lizard, the S. S. E. line  $LA$ , which make equal to 15 miles, parallel to the S. E. line; draw the line  $AB$  equal to 34 miles; again, from  $B$  parallel to W. by S. draw  $BC$  equal to 16 miles; next through  $C$  draw a line parallel to W. N. W. which make equal to 39 miles, from  $D$  draw  $DE$ , parallel to the S. by E. line, equal to 40 miles; then is  $E$  the place of the ship at the end of her several courses,  $EL$  the distance,  $LM$  the difference of latitude,  $EM$  her departure, and the angle  $ELM$  the course she has made good.

To



To find the same by **CALCULATION.**

For the first Course, S. S. E. 15 Miles.

To find the Diff. of Latitude.

As radius  $90^\circ$  10.00000  
Is to distance 15' 1.17609  
So is co-sine course 2 pts. 9.96562

11.14171

10.00000

To diff. lat. 13,9

1.14171

For the Departure.

As radius  $90^\circ$  10.00000  
Is to distance 15' 1.17609  
So is sine course 2 pts. 9.58284

10.75993

10.00000

To departure 5,7

0.75993

Second Course S. E. 34 Miles.

For Difference of Latitude.

As radius  $90^\circ$  10.00000  
Is to co-sine course  $45^\circ$  9.84948  
So is distance 34 1.53148

11.38096

10.00000

To difference lat. 24

1.38096

For Departure.

As radius  $90^\circ$  10.00000  
To sine course  $45^\circ$  9.84948  
So is distance 34 1.53148

11.38096

10.00000

To departure 24

1.38096

Third Course W. by S. 16 Miles.

For Difference of Latitude.

As radius  $90^\circ$  10.00000  
Is to co-sine co.  $78^\circ 45'$  9.29024  
So is distance 16 1.20412

10.49436

10.00000

To diff. latitude 3,1

0.49436

For Departure.

As radius 10.00000  
Is to sine cou.  $78^\circ 45'$  9.99157  
So is distance 16 1.20412

11.19569

10.00000

To departure 15,7

1.19569

Fourth Course W. N. W. 39 Miles.

For Difference of Latitude.

As radius  $90^\circ$  10.00000  
To co-sine cou.  $67^\circ 30'$  9.58284  
So is distance 39 1.59106

11.17390

10.00000

To diff. latitude 14,9

1.17390

For Departure.

As radius  $90^\circ$  10.00000  
Is to sine cou.  $67^\circ 30'$  9.96568  
So is the distance 39 1.59106

11.55668

10.00000

To departure 36

1.55668

Fifth

## Fifth Course S. by E. 40 Miles.

| For Difference of Latitude. |          |  | For Departure.             |          |  |
|-----------------------------|----------|--|----------------------------|----------|--|
| As radius 90°               | 10.00000 |  | As radius 90°              | 10.00000 |  |
| to co-fine cou. 11° 15'     | 9.99157  |  | Is to fine of cou. 11° 15' | 9.29024  |  |
| So is distance 40           | 1.60206  |  | So is distance 40          | 1.60206  |  |
|                             | <hr/>    |  |                            | <hr/>    |  |
|                             | 11.59363 |  |                            | 10.89230 |  |
|                             | <hr/>    |  |                            | <hr/>    |  |
|                             | 10.00000 |  |                            | 10.00000 |  |
|                             | <hr/>    |  |                            | <hr/>    |  |
| To diff. lat. 39,2          | 1.59363  |  | To departure 7,8           | 0.89230  |  |

Though this method of finding the difference of latitude and departure by logarithms is certain, yet the same may be more readily found by tables of difference of latitude and departure; that is, to find the difference of latitude and departure for each course and distance by inspection, and placing them down as in the following traverse table :

| Courses. | Dist. | Diff. Lat. |      | Departure. |      |
|----------|-------|------------|------|------------|------|
|          |       | N.         | S.   | E.         | W.   |
| S. S. E. | 15    |            | 13,9 | 5,7        |      |
| S. E.    | 34    |            | 24,0 | 24,0       |      |
| W. by S. | 16    |            | 3,1  |            | 15,7 |
| W. N. W. | 39    | 14,9       |      |            | 36,0 |
| S. by E. | 40    |            | 39,2 | 7,8        |      |
| From sum | -     | 14,9       | 80,2 | 37,5       | 51,7 |
| Take     | -     |            | 14,9 |            | 37,5 |
|          | -     | -          |      |            |      |
| Refts    | -     | -          | 65,3 |            | 14,2 |

Having placed them as above, add up all the westings, eastings, northings and southings, separately, and set down their respective sums at the bottom of each column; and as the westing is greater than the easting, subtract the easting therefrom, and the difference 14,2 shews that the ship's departure is so much west of her first meridian.

Again, the southing being greater than the northing, subtract the northing from it, and the remainder shews how far the ship is to the southward of her first place.

To

To find the direct Course or Bearing of the Lizard from the ship.

|                          |          |
|--------------------------|----------|
| As the diff. lat. 65,3   | 1.81491  |
| Is to radius 90°         | 10.00000 |
| So is the departure 14,2 | 1.15229  |

|          |
|----------|
| 11.15229 |
| 1.81491  |

|                      |         |
|----------------------|---------|
| To tan. cou. 12° 16' | 9.33738 |
|----------------------|---------|

Which, because the difference of latitude is southerly, and the departure westerly, is S. 12° 16' W. Whence the Lizard bears from the ship N. 12° 16' E. or N. by E. 1° 1' E.

To find the direct Distance.

|                         |          |
|-------------------------|----------|
| As sine of cou. 12° 16' | 9.32728  |
| Is to the depart. 14,2  | 1.15229  |
| So is radius 90°        | 10.00000 |

|          |
|----------|
| 11.15229 |
| 9.32728  |

|                       |         |
|-----------------------|---------|
| To the distance 66,84 | 1.82501 |
|-----------------------|---------|

The course and distance may be found sufficiently near under 12 degrees in the tables, where the distance is 67 miles.

## EXAMPLE II.

Suppose a ship from the Lizard 49° 57' is bound to Cork in latitude 51° 41', N. whose departure from the meridian of the Lizard is 120 miles west, but by reason of contrary winds is obliged to sail on the following courses, viz. S. S. W. 54 miles, W. by S. 39, N. W. by N. 40, N. E. by E. 69, and N. N. W. 60 miles; I demand the direct course distance, difference of latitude and departure made good upon the several courses, with the latitude she is in, and what course she must afterwards steer, and how far to gain her intended port?

W  
meri  
east  
two  
the  
distan  
first

By



## ce.

32728  
15229  
00000

$$\begin{array}{r} 15229 \\ 32728 \\ \hline 32501 \end{array}$$


lati-  
card is  
on the  
by N.  
direct  
upon  
e the

By

## Draw

Draw the W. by S. rhumb; and parallel to it a line, passing through the ship's last place; and upon it set off 39 for the second distance; draw the N. W. by N. rhumb; and parallel to it, as before, draw a line, passing through the ship's last place; upon it set off 40, and that will be the place of the ship at the end of her third course; then draw the N. E. by E. rhumb; and parallel to it a line, passing through the ship's last place; and upon it set off 69 for the fourth distance; then draw a N. N. W. rhumb; and parallel to it a line, as before, through the ship's last place; and upon it set off the last distance 60, which is the ship's place at the end of her several courses; from which draw a line parallel to the east and west line, until it cuts the meridian: for the whole departure, from this to the centre, being measured on the same scale, will give her difference of latitude made good upon the several courses; and a line drawn from the ship's last place to her first, will give the whole distance; and the angle which this line makes with the meridian, will be the ship's course made good.

Now, to find what course she must steer, and how far she must run, from the centre of the compass, or the Lizard point, set off the whole difference of latitude of the two ports, viz. 104, to F.; through F. draw an E. and W. line westerly, and set off thereon the whole departure 120 from F. to E.; then will E. represent the situation of Cork; join AE, and draw AD parallel to the meridian; then will AE be the distance she has to run to her intended port, the angle EAD is the course she must steer, ED is how far she is to the eastward of it, and AD is how far to the southward of it.

### By CALCULATION.

With the difference of latitude, and westing and easting of the two ports, to find their bearings and distances asunder.

| To find the Bearing.          |     |                | To find their Distances.     |        |                |
|-------------------------------|-----|----------------|------------------------------|--------|----------------|
| As diff. of lat.              | 104 | 2.01703        | As radius                    |        | 10.0000        |
| Is to radius                  | 90° | 10.0000        | To diff. lat.                | 104    | 2.01703        |
| So is whole dep.              | 120 | 2.07918        | So is sec. cou.              | 49° 5' | 10.18378       |
|                               |     | <hr/> 12.07918 |                              |        | <hr/> 12.20081 |
|                               |     | 2.01703        |                              |        | 10.0000        |
| <hr/> To tang. bearing 49° 5' |     |                | <hr/> To dist. asunder 158,8 |        |                |
|                               |     | 10.06215       |                              |        | 2.20081        |

Or N. W.  $\frac{1}{4}$  W.

S. E.  $\frac{1}{4}$  E.

1° 16' from each other; or with the difference of latitude and departure, the course will be found by inspection to be 49°, and distance 159 miles; and the several courses and distances being found, will stand as in the following:

TRAVERSE

## TRAVERSE TABLE.

| Courses.    | Dist. | Diff. Lat. |      | Departure. |       |
|-------------|-------|------------|------|------------|-------|
|             |       | N.         | S.   | E.         | W.    |
| S. S. W.    | 54    |            | 49.9 |            | 20.7  |
| W. by S.    | 39    |            | 7.6  |            | 38.2  |
| N. W. by N. | 40    | 33.3       |      |            | 22.2  |
| N. E. by E. | 69    | 38.3       |      | 57.4       |       |
| N. N. W.    | 60    | 55.4       |      |            | 23    |
| From        | -     | 127.0      | 57.5 | 57.4       | 104.1 |
| Take        | -     | 57.5       | -    | -          | 57.4  |
| Remains     | -     | 69.5       | -    | -          | 46.7  |

To find her direct Course and Distance made good.

To find the Course.

|                 |      |          |
|-----------------|------|----------|
| As diff. lat.   | 69.5 | 1.84198  |
| Is to radius    | 90°  | 10.0000  |
| So is departure | 46.7 | 1.66932  |
|                 |      | 11.66932 |
|                 |      | 1.84198  |

To find the Distance.

|                   |         |          |
|-------------------|---------|----------|
| As radius         |         | 10.00000 |
| To diff. lat.     | 69,5    | 1.84198  |
| So is sec. course | 33° 57' | 10.08092 |
|                   |         | <hr/>    |
|                   |         | 11.92290 |
|                   |         | 10.00000 |

|               |         |         |             |       |         |
|---------------|---------|---------|-------------|-------|---------|
| To tang. cou. | 33° 54' | 9.82734 | To distance | 83.73 | 1.92290 |
|---------------|---------|---------|-------------|-------|---------|

Or, with the proper difference of 69.5, and the departure 46.7, look in the tables of difference of latitude and departure, the nearest numbers corresponding to these are 69.6 and 47 under 34° against distance 84.

To find the Bearing and Distance to the intended Port.

|                                              |                     |          |                              |               |          |
|----------------------------------------------|---------------------|----------|------------------------------|---------------|----------|
|                                              |                     |          |                              | In Angle AED. |          |
| Lizard's latitude                            | 49.57               |          | From whole diff. lat. ports  |               | 104      |
| Add northing of ship                         | 1.9                 |          | Subtract ship's northing     |               | 69.5     |
|                                              |                     |          |                              |               |          |
| Ship's latitude in                           | 51.6                |          | Remains ship southw. of port |               | 34.5     |
| From whole departure subtract ship's depart. | 120 — 47 = 73 = ED. |          |                              |               |          |
| As A D                                       | 34.5                | 1.53782  | As radius 90                 |               | 10.0000  |
| Is to radius                                 | 90°                 | 10.00000 | AD 34.5                      |               | 1.53782  |
| So is E D                                    | 73                  | 1.86332  | So is sec. course 64° 42'    |               | 10.36921 |
|                                              |                     |          |                              |               |          |
|                                              |                     | 11.86332 |                              |               | 11.90703 |
|                                              |                     | 1.53782  |                              |               | 10.00000 |

|                                                                                |          |                                  |         |
|--------------------------------------------------------------------------------|----------|----------------------------------|---------|
| To tang. cou. she must<br>steer nearly N. E. by<br>E. $\frac{3}{4}$ E. 64° 42' | 10.32550 | To dist. she has<br>to run 80.73 | 1.90703 |
|--------------------------------------------------------------------------------|----------|----------------------------------|---------|

K 2

Or



Or, with the difference of latitude 34,5 and departure 73, look into the tables, the nearest numbers to these are 73,4, and 34,2 standing over 65 against distance 81.

All the preceding may be found by Gunter's Scale, but shall leave the working of them to exercise the Learner, who ought to be well acquainted with Traverse Sailing; and for that purpose it has been thought proper to subjoin the following, which is the most general and useful that well can be, and may be worked by any of the foregoing methods.

A ship being at sea in latitude  $37^{\circ} 10' N.$  is bound to a port, which lies to the westward in latitude  $23^{\circ} 0' N.$  the departure between the ship and the place is 180 miles; consequently, by Case VI. the course will be S. W. by S. 2 degrees westerly, and distance 301 miles, but the wind being variable, is obliged to ply upon these several courses, the distance run upon each, being obtained by the log, and the first she fails (with her larboard tacks on board) S. W. by W. 27 miles, W. S. W. half W. 30 miles, W. by S. 25 miles, W. by N. 18 miles.

(Starboard tacks on board wind shifting) S. S. E. 32 miles, S. S. E. three-quarters E. 27 miles, S. by E. 25 miles, S. 31 miles, S. S. E. 39 miles.

Required the latitude the ship is in and her departure from the meridian, upon what course she must steer if possible, and how far she must sail to gain her intended port?

The difference of latitude and departure being found by the preceding directions, will stand as in the following Table:

The TRAVERSE TABLE.

| Courses.                  | Dist. | Diff. of Lat.       |       | Departure. |         |
|---------------------------|-------|---------------------|-------|------------|---------|
|                           |       | N.                  | S.    | E.         | W.      |
| S. W. by W.               | 27    |                     | 15,0  |            | 22,4    |
| W. S. W. $\frac{1}{2}$ W. | 30    |                     | 8,7   |            | 28,7    |
| W. by S.                  | 25    |                     | 4,9   |            | 24,5    |
| W. by N.                  | 18    | 3,5                 |       |            | 17,7    |
| S. S. E.                  | 32    |                     | 29,6  | 12,2       |         |
| S. S. E. $\frac{3}{4}$ E. | 27    |                     | 23,2  | 13,9       |         |
| S. by E.                  | 25    |                     | 24,5  | 4,9        |         |
| South.                    | 31    |                     | 31,0  |            |         |
| S. S. E.                  | 39    |                     | 36,0  | 14,9       |         |
|                           |       | 3,5                 | 172,9 | 45,9       | 93,3    |
|                           |       |                     | 3,5   |            | 45,9    |
|                           |       | Diff. Lat. 169,4 S. |       | Depar.     | 47,4 W. |

The ship is in latitude  $34^{\circ} 20'$  N. the departure is 47.4 W.

The course made good is S.  $19^{\circ} 35'$  W. and distance 175.9.

The course to the intended port is S.  $58^{\circ} 54'$  W. or S. W. by W. one-quarter west nearly, distance 155.2.

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## MIDDLE LATITUDE SAILING.

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IN Plane Sailing the Earth was considered as a plane, representing a bowling green, having the meridians parallel to each other, and consequently the degrees of longitude equal in all places; but this cannot be true, as the earth is a globe or sphere; for,

As the meridians are circles on the terraqueous globe, meeting in the poles, (as may be seen in the following figure) it is obvious, that any two of those circles must recede more at greater distances from the poles; and at equal distances from each pole, or at the equator, the distance between the meridians is greatest.

The true place of a ship at sea depends upon its distance from the Equator, and some noted Meridian; and since the Meridional distance, that is, the distance between any two Meridians, varies in every latitude, it is therefore convenient this distance should be reckoned in a fixed latitude; and where the degrees are of the same magnitude with those of the meridian, which can be no where but on the equator, where 60 geographical miles make a degree.

The circumference of all circles are in direct proportion to each other, as their radii: and since the earth turns once round its axis in 24 hours, every point upon its surface must describe circles parallel to the equator: hence it follows, that the circumference of any parallel of latitude in miles, is to the circumference of the Equator in miles, as the co-sine of that latitude is to radius; and, that the breadth of a degree, in any parallel or latitude, is to the breadth of a degree upon the equator, as the sine complement of that latitude is to radius.

By the last proportion was the following table calculated, which shews the breadth of a degree of longitude in every latitude; and may be made to answer for any degrees or minutes by taking proportional parts:

The

*The following Table shews how many Miles answer to a Degree of Longitude at every Degree of Latitude.*

| D.L. | Miles. | D.L. | Miles. | D.L. | Miles. | D.L. | Miles. | D.L. | Miles. |
|------|--------|------|--------|------|--------|------|--------|------|--------|
| 1    | 59 99  | 19   | 56 73  | 37   | 47 92  | 55   | 34 41  | 73   | 17 54  |
| 2    | 59 96  | 20   | 56 38  | 38   | 47 38  | 56   | 33 55  | 74   | 16 53  |
| 3    | 59 92  | 21   | 56 01  | 39   | 46 62  | 57   | 32 68  | 75   | 15 52  |
| 4    | 59 86  | 22   | 55 63  | 40   | 45 95  | 58   | 31 79  | 76   | 14 51  |
| 5    | 59 77  | 23   | 55 23  | 41   | 45 28  | 59   | 30 90  | 77   | 13 50  |
| 6    | 59 67  | 24   | 54 81  | 42   | 44 59  | 60   | 30 00  | 78   | 12 48  |
| 7    | 59 56  | 25   | 54 38  | 43   | 43 88  | 61   | 29 19  | 79   | 11 45  |
| 8    | 59 42  | 26   | 53 93  | 44   | 43 16  | 62   | 28 17  | 80   | 10 42  |
| 9    | 59 26  | 27   | 53 56  | 45   | 42 43  | 63   | 27 24  | 81   | 9 38   |
| 10   | 59 08  | 28   | 52 97  | 46   | 41 68  | 64   | 26 30  | 82   | 8 35   |
| 11   | 58 89  | 29   | 52 47  | 47   | 40 92  | 65   | 25 36  | 83   | 7 32   |
| 12   | 58 68  | 30   | 51 96  | 48   | 40 15  | 66   | 24 41  | 84   | 6 28   |
| 13   | 58 46  | 31   | 51 43  | 49   | 39 36  | 67   | 23 45  | 85   | 5 23   |
| 14   | 58 22  | 32   | 50 88  | 50   | 38 57  | 68   | 22 48  | 86   | 4 18   |
| 15   | 57 95  | 33   | 50 32  | 51   | 37 76  | 69   | 21 50  | 87   | 3 14   |
| 16   | 57 67  | 34   | 49 74  | 52   | 36 94  | 70   | 20 52  | 88   | 2 09   |
| 17   | 57 37  | 35   | 49 15  | 53   | 36 11  | 71   | 19 54  | 89   | 1 05   |
| 18   | 57 06  | 36   | 48 54  | 54   | 35 26  | 72   | 18 55  |      |        |

Hence it follows, that

|                                           |      |                                                                     |
|-------------------------------------------|------|---------------------------------------------------------------------|
| As co-sine of any paral. of lat.          | AND, | As radius, or sine 90°                                              |
| Is to the dist. run in miles in that lat. |      | Is to the diff. of long. in miles,                                  |
| So is the radius, or sine of 90°          |      | So is co-sine of any paral. of lat.                                 |
| To the diff. of long. in miles.           |      | To the dist. in miles between any Two merid. in that paral. of lat. |

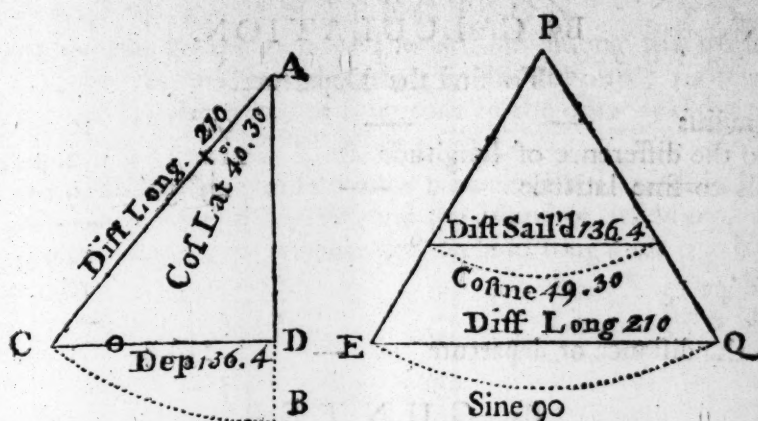
From what has been said arises the solution of the following Problems :

### PROBLEM I.

*The Difference of Longitude between two Places both in one Parallel of Latitude being given, to find the Distance between them.*

Suppose a ship in the latitude 49° 30' N. or S. sails directly E. or W. until her difference of longitude be 3° 30', and the distance sailed be required ?





## By PROJECTION.

With the sine of  $90^\circ$  in your compasses taken from the Plane scale, and with one foot in P describe the arch EQ, and upon it set off the difference of longitude 210 miles, and draw the lines PE and EQ to represent the two meridians; and then EQ represent the equator, and P the Pole. Again, with the sine com. of the latitude  $49^\circ 30'$  viz.  $40^\circ 30'$  in your compasses, taken from the line of sines on the Plane Scale, and with one foot in P describe an arch, and the distance between the points, where it cuts the two meridians, being measured upon the same scale of equal parts that the difference of longitude was, will be the departure 136,4 miles.

Or, thus :

Draw the meridian AB, and with the chord of 60 in your compasses describe an arch, and upon it set off the complement of the latitude  $40^\circ 30'$  (taken from the line of chords), and set it off upon the arch as a course in Plane Sailing, and draw the line AC as a distance, which make equal to the difference of longitude 210 miles; then will the departure CD be the distance 136,4 miles, as before: This last method is preferable to the former, as we are not confined to any particular scale.

Reverse this Problem, and suppose the distance sailed in any parallel of latitude given, to find the difference of longitude.

With the sine com. of latitude in your compasses describe an arch, upon which set off the departure 136,4 miles, and through the points where it cuts the arch draw the lines PE and PQ; then with the sine of  $90^\circ$  in the compasses, and one foot in the former centre P, describe an arch to cut PE and PQ; then EQ being measured upon the small scale of equal parts that the departure was, will be the difference of longitude 210 miles.

By

## MIDDLE LATITUDE SAILING.

## By CALCULATION.

To find the Departure.

|                                   |   |         |          |
|-----------------------------------|---|---------|----------|
| As radius                         | — | 90°     | 10.00000 |
| Is to the difference of longitude | — | 210     | 2.32222  |
| So is co-sine latitude            | — | 49° 30' | 9.81254  |
|                                   |   |         | <hr/>    |
|                                   |   |         | 12.13476 |
|                                   |   |         | 10.00000 |
|                                   |   |         | <hr/>    |
| To the distance or departure      | — | 136,4   | 2.13476  |

## By GUNTER.

'The extent from radius to sine com. latitude 49° 30' on the line of sines, will reach from the difference of longitude 210 to the distance 136,4 on the line of numbers.'

## By INSPECTION.

Find the sine com. of the latitude among the degrees, and in the distance column the difference of longitude, opposite to which, in the column of departure, is the distance required; but as the co-latitude is 40° 30', therefore,

|                               |       |
|-------------------------------|-------|
| For 40 degrees you will find  | 135   |
| For 41 degrees you will find  | 137,7 |
|                               | <hr/> |
| The sum is                    | 272,7 |
|                               | <hr/> |
| Half is the distance required | 136,3 |

This is done because the table of difference of latitude and departure is calculated only for single degrees.

By the reverse of the last Problem, having the distance run in any parallel to find the difference of longitude.

Suppose a ship in latitude 49° 30' N. or S. sails directly E. or W. 136,4 miles, and her difference of longitude be required?

|                        |         |          |
|------------------------|---------|----------|
| As co-sine of latitude | 49° 30' | 9.81254  |
| Is to the distance     | 136,4   | 2.13481  |
| So is radius           |         | 10.00000 |
|                        |         | <hr/>    |
|                        |         | 12.13481 |
|                        |         | 9.81254  |
|                        |         | <hr/>    |

To the difference of longitude 210. 2.32227

## By INSPECTION.

Look for the complement of the latitude among the degrees as if it was a course, and the departure in its column ; right against which stands the difference of longitude in the distance column.

## C A S E I.

Required the bearing and distance between the Lizard, in latitude  $49^{\circ} 57' N.$  longitude  $5^{\circ} 14' W.$  and the Island of St. Mary, one of the Western Islands, in latitude  $37^{\circ} N.$  and longitude  $25^{\circ} 6' W.$

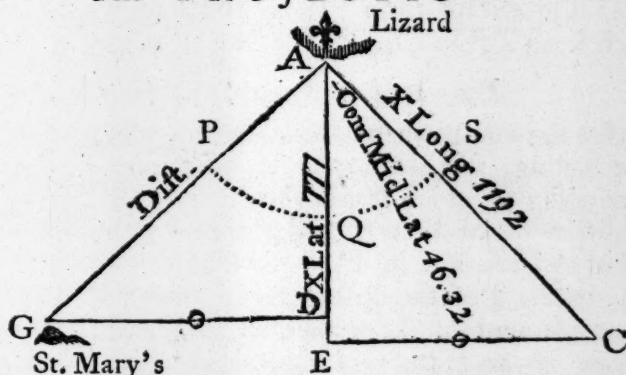
Lizard's lat.  $49^{\circ} 57' N.$   $49^{\circ} 57'$  Long.  $5^{\circ} 14' W.$

St. Mary's lat.  $37^{\circ} 00' N.$   $37^{\circ} 00'$  Long.  $25^{\circ} 6' W.$

|                    |       |                 |                  |
|--------------------|-------|-----------------|------------------|
|                    | 12 57 | Sum 2 ) 86 57   | 19 52            |
|                    | 60    |                 | 60               |
|                    | <hr/> | Mid. lat. 43 28 | <hr/>            |
| Diff. in miles 777 |       | 90 00           | 1192 diff. long. |
|                    |       | <hr/>           |                  |

Co-mid. lat.  $46^{\circ} 32'$

## The PROJECTION.



Draw the meridian  $AE$ , with the chord of 60 describe the arch  $PS$ ; upon which set off  $46^{\circ} 32'$  the complement of middle latitude, from  $Q$  to  $S$ ; through  $S$  draw the line  $AC = 1192$ , the difference of longitude; let fall the perpendicular  $CE$ , which will be the departure 865; upon  $AE$  set off  $AD = 777$ , the difference of latitude, and upon  $D$  erect the perpendicular  $DG$ , and upon it set off the departure 865; join  $G$  and  $A$ , and it is done; for  $GA$  will be the distance 1168 miles, and the angle  $GAD$  the course  $S. 48^{\circ} 4' W.$

## The CALCULATION.

To find the Departure.

|                                         |          |
|-----------------------------------------|----------|
| As radius 90                            | 10.00000 |
| Is to diff. of long. 1192               | 3.07628  |
| So is co-fi. mid. lat. $43^{\circ} 28'$ | 9.86080  |
|                                         | <hr/>    |
|                                         | 12.93708 |
|                                         | 10.00000 |
|                                         | <hr/>    |

To the departure 865, 1 2.93708

To find the Course.

|                        |          |
|------------------------|----------|
| As diff. of lat. 777   | 2.89042  |
| Is to radius 90        | 10.00000 |
| So is departure 865, 1 | 2.93708  |
|                        | <hr/>    |
|                        | 12.93708 |
|                        | 2.89042  |
|                        | <hr/>    |

To tang. of cou.  $48^{\circ} 4'$  10.04666

L

To



## To find the Distance.

|                                    |          |
|------------------------------------|----------|
| As radius                          | 10.00000 |
| Is to diff. latitude 777           | 2.89042  |
| So is sec. of cou. $48^{\circ} 4'$ | 10.17505 |
|                                    | <hr/>    |
|                                    | 13.06547 |
|                                    | 10.00000 |
|                                    | <hr/>    |
| To the distance 1163               | 3.06547  |

NOTE. The course may be found without the departure, by Middle Latitude Sailing, thus:

|                                        |          |
|----------------------------------------|----------|
| As the diff. lat. 777                  | 2.89042  |
| Is to diff. long. 1192                 | 3.07621  |
| So is co-f. mid. lat. $43^{\circ} 28'$ | 9.86088  |
|                                        | <hr/>    |
|                                        | 12.93751 |
|                                        | 2.89042  |
|                                        | <hr/>    |
| To tang. of cou. $48^{\circ} 4'$       | 10.04661 |

## By G U N T E R.

1st. 'The extent from  $46^{\circ} 32'$  the complement of the middle latitude to radius on the line of lines, will reach from 1192 to 865,1 on the line of numbers.

2dly. 'The extent from radius or  $90^{\circ}$  to  $41^{\circ} 56'$  the complement of the course on the lines, will reach from 777 to 1163 on the line of numbers.

3dly. 'The extent from 777 to 865,1 on the line of numbers will reach from  $45^{\circ}$  to  $48,4$  on the line of tangents.'

## By I N S P E C T I O N.

Look for the complement of middle latitude, as if it was a course in Plane Sailing, and difference of longitude in the distance column; opposite to which stands the departure in its column. Having the difference of latitude and departure, the course and distance is found as in Case VI. in Plane Sailing.

Thus, taking  $\frac{1}{4}$  of the difference of longitude  $1192 = 298$ , and as the complement of the middle latitude is  $46^{\circ} 32'$ , or nearly  $46^{\circ}$ , I look over 46 and 47, and against the distance stands 214,4 and 218 in the departure columns; which added together gives 432,4; half is 216,2; this multiplied by 4 gives 864,8, the departure.

Again, taking  $\frac{1}{4}$  the difference of latitude, and  $\frac{1}{4}$  of the departure 194,2 and 216,2; the nearest number to these standing together are 216,2 and 194,7 over  $48^{\circ}$  and against the distance 291; this multiplied by 4 gives 1164 miles: hence the course is S.  $48^{\circ}$  W.; and distance 1164.

## C A S E II.

*Both Latitude and Departure from the Meridian given, to find the Course and Distance, and Difference of Longitude.*

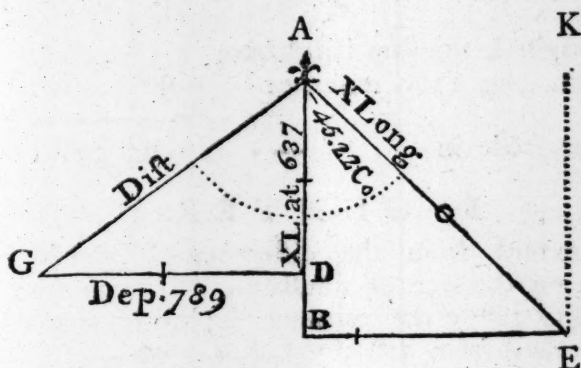
A ship in latitude  $49^{\circ} 57'$  N. and longitude  $5^{\circ} 24'$  W. sailed south westerly, till her departure is 789 miles, and she be in latitude  $39^{\circ} 20'$  N.; I demand the course, distance, and longitude she is in?

Latitude

# MIDDLE LATITUDE SAILING.

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|                   |            |                    |            |
|-------------------|------------|--------------------|------------|
| Latitude left     | 49° 57' N. | Latitude left      | 49° 57' N. |
| Latitude in       | 39 20 N.   | Latitude in        | 39 20 N.   |
| Diff. of latitude | 10 37      | Sum of latitude    | 89 17 N.   |
|                   | 60         | Middle latitude    | 44 38      |
| n miles           | 637        |                    | 90 00      |
|                   |            | Comp. of mid. lat. | 45 22      |



## CONSTRUCTION.

Draw the meridian A D, from A to D set off the difference of latitude 637 miles, and on D erect the perpendicular D G, which make equal to the departure 789 miles. Draw the line A G, and that will be the distance 1014 miles, and the angle D A G the course  $51^{\circ} 5'$ .

Again, draw E K parallel to A D, making the distance from D equal to the departure D G 789, on A describe an arch; take the complement of the middle latitude  $45^{\circ} 22'$  in your compasses from the line of chords, and set that off on the arch on the opposite side of the meridian A D, through where that cuts the arch draw the line A E to the line K E in E, from E let fall the perpendicular E B, and is done; for A E will be the difference of longitude 1109 miles.

## By CALCULATION.

To find the Course it will be,

|                                 |          |
|---------------------------------|----------|
| As the diff. of lat. 637        | 2.80414  |
| to radius $90^{\circ}$          | 10.00000 |
| so is departure 789             | 2.89708  |
|                                 | 12.89708 |
|                                 | 2.80414  |
| to tang. course $51^{\circ} 5'$ | 10.09294 |

To find the Distance it will be,

|                                    |          |
|------------------------------------|----------|
| As the fine course $51^{\circ} 5'$ | 9.89101  |
| Is to the departure 789            | 2.89708  |
| So is radius $90^{\circ}$          | 10.00000 |
|                                    | 12.89708 |
|                                    | 9.89101  |
| To the distance 1014               | 3.00607  |

To find the Difference of Longitude it will be,

|                            |         |          |
|----------------------------|---------|----------|
| As co-sine middle latitude | 44° 38' | 9.85225  |
| Is to departure            | 789     | 2.89708  |
| So is radius               | 90°     | 10.00000 |
|                            |         | <hr/>    |
|                            |         | 12.89708 |
|                            |         | 9.85225  |
|                            |         | <hr/>    |

To difference of longitude 1109 3.04483

Longitude the ship sailed from 5° 24' W.  
Diff. long 1109 miles, or 18° 29' W.

Longitude in — 23 53 W.

By G U N T E R.

1st. The extent from the difference of latitude 637 to the departure 789 on the line of numbers, will reach from radius, or 45° backward to 51° 5' the course on the line of tangents.

2dly. The extent from 51° 5' to radius or 90° on the line of sines, will reach from the departure 789 to the distance 1014 on the line of numbers.

3dly. The extent from the complement of middle latitude 45° 22' to radius or 90° on the line of sines, will reach from the departure 789, to the difference of longitude 1109 on the line of numbers.

By I N S P E C T I O N.

RULE. With the difference of latitude and departure, find the course and distance, as in Case VI. in Plane Sailing.

2dly. Taking the complement of middle latitude as a course, and the departure in its column, and the distance corresponding to these, will be the difference of longitude.

Thus, taking a tenth of the difference of latitude 637 and departure 789, that is 63,7 and 78,9, the nearest numbers to these are 63,6 and 78,5 standing together over 51°, against the distance 1010 which multiplied by 10 gives 1010; whence the course by inspection is S. 51° W. and the distance 1010.

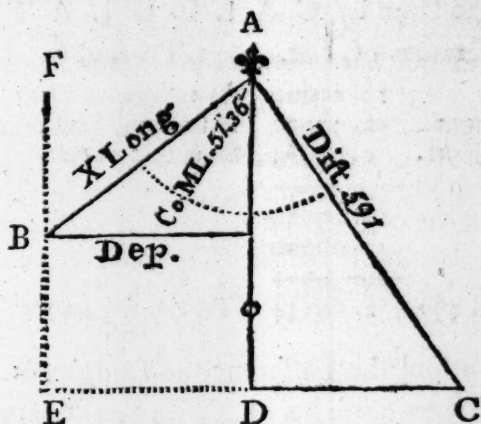
Taking 45° 22' or 45° as a course, and a tenth of the departure 78,9 in its column, the nearest is 78,5, in the distance column stands 111, which multiplied by 10 gives 1110 for the difference of longitude nearly, as before.



## CASE III.

One Latitude, Course and Distance given, to find the Difference of Latitude and Difference of Longitude.

A ship in latitude  $42^{\circ} 30' N.$  and longitude  $18^{\circ} 31' W.$  sails S. E. by S. 591 miles, or 197 leagues; I demand the latitude and longitude the ship is in?



By PROJECTION.

With the course and distance, find the difference of latitude and departure, as in Case I. in Plane Sailing, viz. Draw the meridian  $AD$ , and on  $A$  describe an arch with the chord of  $60^{\circ}$ , and upon it set off the course S. E. by S. or 3 points, through where that cuts the arch draw the line  $AC$ , making it equal to the distance 591, from  $C$  let fall the perpendicular  $CD$ ; then will  $CD$  be the departure, and  $AD$  the difference of latitude 491 miles.

Draw the line  $EF$  parallel to  $AD$ , making the distance from it equal to the departure.

Take the complement of middle latitude  $51^{\circ} 36'$  from the line of chords in your compasses, and set it off on the arch on the other side of the meridian  $AD$ , and through where that cuts the arch draw the line  $AB$  to cut the line  $EF$  in  $B$ , from  $B$  let fall the perpendicular  $ED$ , and it is done; for  $AB$  will be the difference of longitude, 419 miles.

|                        |                     |                         |                     |
|------------------------|---------------------|-------------------------|---------------------|
| Latitude left          | $42^{\circ} 30' N.$ | Longitude left          | $18^{\circ} 31' W.$ |
| Difference of latitude | $8 \ 11 \ S.$       | Difference of longitude | $6 \ 59 \ E.$       |
| Latitude in            | $34 \ 19 \ N.$      | Longitude in            | $11 \ 32 \ W.$      |
| Latitude left          | $42 \ 30$           |                         |                     |
| Sum                    | $76 \ 49$           |                         |                     |
| Middle latitude        | $38 \ 24$           |                         |                     |
| Com. middle latitude   | $51 \ 36$           |                         |                     |

From

From what has been said, it will be easy to construct any of the following cases, as they are constructed the same as in Plane-Sailing: only observing, that to find the difference of longitude you must take the complement of middle latitude as a course in Plane Sailing, with this course and the departure find the distance, and that will be the difference of longitude.

### To find the same by CALCULATION.

To find the Difference of Lat.

|                           |          |
|---------------------------|----------|
| As radius $90^\circ$      | 10.00000 |
| Is to the distance 591    | 2.77159  |
| So is co-sine cou. 3 pts. | 9.91985  |
|                           | <hr/>    |
|                           | 12.69144 |
|                           | <hr/>    |
|                           | 10.00000 |

To the diff. of lat. 491,4 2.69144

To find the Departure.

|                          |          |
|--------------------------|----------|
| As radius $90^\circ$     | 10.00000 |
| Is to the distance 591   | 2.77159  |
| So is sine course 3 pts. | 9.74474  |
|                          | <hr/>    |
|                          | 12.51633 |
|                          | <hr/>    |
|                          | 10.00000 |

To the departure 328,3 2.51633

### To find the Difference of Longitude.

Without the Departure it will be,

|                                    |          |
|------------------------------------|----------|
| As co-fi. mid. lat. $38^\circ 24'$ | 9.89415  |
| Is to sine course 3 pts.           | 9.74474  |
| So is distance 591                 | 2.77159  |
|                                    | <hr/>    |
|                                    | 12.51633 |
|                                    | <hr/>    |
|                                    | 9.89415  |

To diff. of long. 419 2.62218

With the Departure it will be,

|                                    |          |
|------------------------------------|----------|
| As co-fi. mid. lat. $38^\circ 24'$ | 9.89415  |
| Is to departure 328,3              | 2.51627  |
| So is radius $90^\circ$            | 10.00000 |
|                                    | <hr/>    |
|                                    | 2.51627  |
|                                    | <hr/>    |
|                                    | 9.89415  |

To diff. of lon. 419 =  $6^\circ 59' 2.62218$   
Long. left  $18^\circ 31' W.$

Whence the ship is in lat.  $34^\circ 19' N.$  and long.

$11^\circ 32' W.$

### By GUNTER.

1st. 'The extent from radius or 8 points to the complement of the course, 5 points on the line marked S. R. will reach from the distance 591 to 491 the difference of latitude on the line of numbers.'

2dly. 'The extent from radius or 8 points to the course, 3 points on the line S. R. will reach from the distance 591 to the departure 328 on the line of numbers.'

3dly. 'The extent from the sine complement middle latitude  $51^\circ 36'$  to radius or  $90^\circ$  on the line of sines, will reach from the departure 328 to the difference of longitude 419 on the line of numbers.'

By

## By INSPECTION.

**RULE.**—With the course and distance find the difference of latitude and departure, as in Case the First in Plane Sailing.

2dly. Take the complement of middle latitude as a course and the departure in its column, and against it in the distance column stands the difference of longitude.

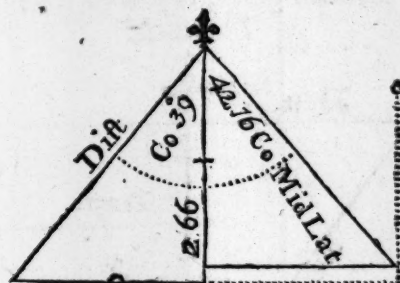
Thus, under the course 3 points, and against a tenth of the distance  $591 = 59$ , stand  $49,1$  and  $32,8$ ; these multiplied by 10 gives  $491$  for the difference of latitude, and  $328$  for the departure.

Now, taking the complement middle latitude  $51^{\circ} 36'$  or  $51^{\circ}$  as a course, and a tenth of the departure  $328 = 32,8$  in its column (the nearest is  $32,6$ ), against which stands  $42$  in the distance column; this multiplied by 10 gives  $420$  the difference of longitude nearly, as before.

If the foregoing directions be well understood, the Learner will not find it difficult to work the following cases in Middle Latitude Sailing.

## CASE. IV.

*Course and Difference of Latitude given, to find the Departure, Distance, and Difference of Longitude.*



Suppose a ship sailing from the Lizard, makes when the variation, lee-way, &c. are allowed for, her course S.  $39^{\circ}$  W. or S. W. by S. half westerly, and then by observation is in latitude  $45^{\circ} 31' N.$ ; what is her distance run, and longitude in?

|                         |                     |                  |                     |
|-------------------------|---------------------|------------------|---------------------|
| Latitude of the Lizard  | $49^{\circ} 57' N.$ | _____            | $49^{\circ} 57' N.$ |
| Latitude by observation | $45 31 N.$          | _____            | $45 31 N.$          |
| Difference of Latitude  | <u>4 26</u>         | Sum of latitudes | <u>95 28</u>        |
|                         | 60                  | Middle latitude  | <u>47 44</u>        |
| In miles                | <u>266</u>          | Co-middle lat.   | <u>42 16</u>        |

By



## By CALCULATION.

To find the Departure it will be,

|                         |     |         |
|-------------------------|-----|---------|
| As the co-fine course   | 39° | 9.89050 |
| Is to the diff. of lat. | 266 | 2.42488 |
| So is fine course       | 39° | 9.79887 |

|          |
|----------|
| 12.22375 |
| 9.89050  |

To the departure 215,4 2.33325

To find the Diff. of Longitude.

|                       |         |          |
|-----------------------|---------|----------|
| As co-f. of mid. lat. | 47° 44' | 9.82775  |
| Is to the departure   | 215,4   | 2.33325  |
| So is radius          | 90°     | 10.00000 |

|          |
|----------|
| 12.33325 |
| 9.82775  |

To the diff. of long. 320,3 2.50550

To find the Distance it will be,

|                      |     |          |
|----------------------|-----|----------|
| As the co-fi. course | 39° | 9.89050  |
| Is to diff. of lat.  | 266 | 2.42488  |
| So is radius         | 90° | 10.00000 |

|          |
|----------|
| 12.42488 |
| 9.89050  |

To the distance 342,3 2.53438

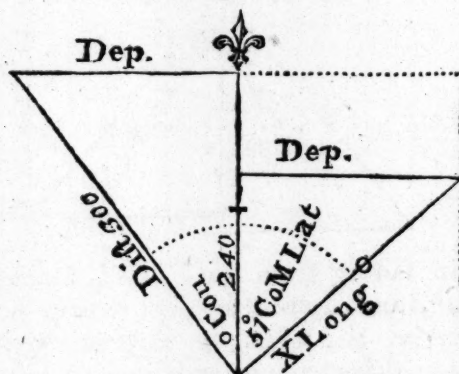
To find the Longitude in.

|                    |                      |
|--------------------|----------------------|
| Lizard's longitude | 5° 14' W.            |
| Diff. of lon.      | 320 miles or 5 20 W. |

Longitude in 10 34 W.

## CASE V.

Both Latitude and Distance given, to find the Course and Difference of Longitude.



Suppose a ship runs 300 miles N. westerly, from a port in 37° N. latitude, and longitude 10° 25' W. until she be in latitude 41° N.; what is her course and longitude in?

|               |            |                 |            |
|---------------|------------|-----------------|------------|
| Latitude left | 37° 00' N. |                 | 37° 00' N. |
| Latitude in   | 41° 00' N. |                 | 41° 00' N. |
| Diff. of lat. | 4 00       | Sum of Latitude | 78 00      |
|               | 60         | Middle latitude | 39 00      |
| In miles      | 240        | Com. mid. lat.  | 51         |

By

# MIDDLE LATITUDE SAILING.

89

## By CALCULATION.

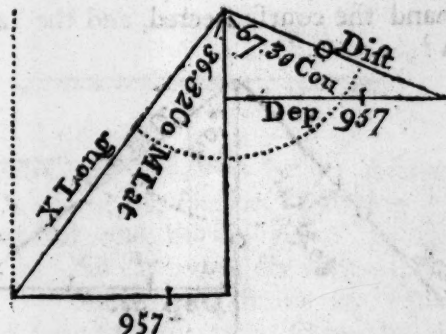
| To find the Course it will be, |              |          | To find the Diff. of Lon. it will be, |          |  |
|--------------------------------|--------------|----------|---------------------------------------|----------|--|
| As the distance                | 300          | 2.47712  | As co-sine mid. lat. $39^{\circ}$     | 9.89050  |  |
| Is to radius                   | $90^{\circ}$ | 10.00000 | Is to tang. course $36.52$            | 9.17501  |  |
| So is diff. of lat.            | 240          | 2.68021  | So is diff. of lat. 240               | 2.38021  |  |
|                                |              | <hr/>    |                                       | <hr/>    |  |
|                                |              | 12.38021 |                                       | 12.25522 |  |
|                                |              | 2.47712  |                                       | 9.89050  |  |

|                                      |         |                         |         |
|--------------------------------------|---------|-------------------------|---------|
| To the co-sine cou. $36^{\circ} 52'$ | 9.90309 | To diff. of long. 231.6 | 2.36472 |
| Longitude left                       | —       | $10^{\circ} 25' W.$     |         |
| Difference of Longitude              | —       | 3 52 W.                 |         |
|                                      |         | <hr/>                   |         |
| Longitude in                         | —       | 14 17 W.                |         |

## CASE VI.

One Latitude, Course, and Departure given, to find the Distance, Difference of Latitude, and Difference of Longitude.

A ship sails E. S. E. from a certain port in latitude  $50^{\circ} 10' S.$  and longitude  $10^{\circ} 16' E.$  until her departure from the Meridian be 957 miles; I demand her distance sailed, and the latitude and longitude she is in?



| To find the diff. of Lat. it will be, |          |  | To find the diff. of Lon. it will be, |          |  |
|---------------------------------------|----------|--|---------------------------------------|----------|--|
| As sine course 6 pts.                 | 9.96562  |  | As co-sine mid. lat. $39^{\circ}$     | 9.89050  |  |
| Is to the departure 957               | 2.98091  |  | Is to tang. course $36.52$            | 9.17501  |  |
| So is co-sine course 6 pts.           | 9.58284  |  | So is diff. of lat. 240               | 2.38021  |  |
|                                       | <hr/>    |  |                                       | <hr/>    |  |
|                                       | 12.56375 |  |                                       | 12.25522 |  |
|                                       | 9.96562  |  |                                       | 9.89050  |  |
|                                       | <hr/>    |  |                                       | <hr/>    |  |
| To the diff. of lat. 396.4            | 2.59813  |  | To diff. of long. 231.6               | 2.36472  |  |

M

To

To find the Distance it will be,

As fine course 6 pts. 9.96562  
Is to the departure 957 2.98091  
So is radius 10.00000

12.98091  
9.96562

To the distance 1036 3.01529

To find the diff. of Long. it will be,

As co-sine mid. lat.  $53^{\circ} 28'$  9.77473  
Is to the departure 957 2.98091  
So is radius 10.00000

12.98091  
9.77473

To the m. dif. of lon. 1608 3.20618

Lat. left  $50^{\circ} 10' S.$

Lat. in  $56 46 S.$

Sum is  $2) 106 56$

Mid. lat.  $53 28$

Co-mid. lat.  $36 32$

Long. left is

Diff. of long. 1608, or  $10^{\circ} 16' E.$

Long. in

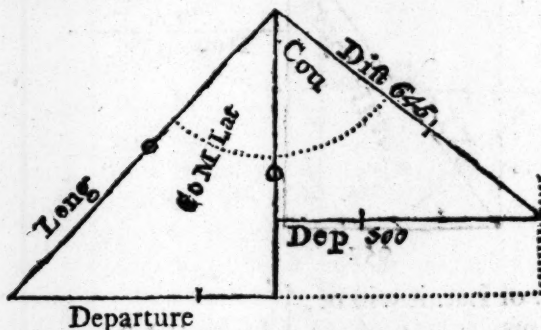
$26 48 E.$

$37 4 E.$

### CASE VII.

*One Latitude, Distance sailed, and Departure from the Meridian given, to find the Course, Difference of Latitude, and Difference of Longitude.*

A ship in latitude  $49^{\circ} 30' N.$  and longitude  $14^{\circ} 40' W.$  sails south eastward 645 miles, until her departure from the meridian be 500 miles; I demand the course steered, and the latitude and longitude the ship is in?



To find the Course it will be,

As the distance 645 2.80956  
Is to the radius 10.00000  
So is the departure 500 2.69897

12.69897  
2.80956

To fine course  $50^{\circ} 50'$  9.88941

To find the Diff. of Lat. it will be,

As radius 10.00000  
Is to the distance 645 2.80956  
So is co-sine cou.  $50^{\circ} 50'$  9.80043

12.60999  
10.00000

To the diff. of lat. 407,3 2.60999

Lat.



# MERCATOR'S SAILING.

51

|                                        |            |                        |            |
|----------------------------------------|------------|------------------------|------------|
| Lat. left is                           | 49° 30' N. | Lat. left              | 49 30      |
| Diff. lat. 407, or                     | 6 47 S.    | Lat. in                | 42 43      |
| Lat. in                                | 42 43 N.   | Sum is                 | 92 13      |
|                                        |            | Middle latitude        | 46 6       |
|                                        |            | Co-mid. lat.           | 43 54      |
| To find the diff. of Long. it will be, |            |                        |            |
| As co-sine mid. lat. 46° 6'            | 9.84098    | Long. left is          | 14° 40' W. |
| Is to the departure 500                | 2.69897    | Diff. of long. 712, or | 12 10 E.   |
| So is radius                           | 10.00000   | Long. in               | 2 30 W.    |
|                                        | 12.69897   |                        |            |
|                                        | 9.84098    |                        |            |
| To the diff. of long. 721, 1 2.85799   |            |                        |            |

# MERCATOR'S SAILING.

**P**LANE SAILING, as has been before observed, supposes the earth and sea to be in the form of a bowling green, on which the meridians are parallel, and the degrees of latitude and longitude equal in all places; but the earth and sea compose a round body or globe, on which the degrees of latitude are equal in all places, and the degrees of longitude decrease from the equator in proportion to the sine complement of the latitude.

Though the meridians all meet at the poles, and the parallels to the Equator continually decrease, and that in proportion to the co-sines of their latitudes; yet in old sea charts the meridians were drawn parallel to each other, and consequently the parallels of latitude made equal to the equator, and so a degree of longitude on any parallel, as large as a degree on the equator: also in these charts the degrees of latitude were still represented (as they are in themselves) equal to each other, and to those of the equator; by these means the degrees of longitude being increased beyond their just proportion, and the more so the nearer they approach the pole, the

M 2

degrees

degrees of latitude at the same time remaining the same, it is evident places must be very erroneously marked down upon those charts, with respect to their latitude and longitude, and consequently their bearing from one another must be very false.

To remedy this inconvenience, so as still to keep the meridians parallel, it is plain we must protract or lengthen the degrees of latitude in the same proportion as those of longitude are, that so the proportion in easting or westing may be the same with that of northing or southing; and consequently the bearing of places from each other to be the same upon the chart as upon the globe itself.

The difficulty in constructing a true sea-chart consists in finding a proper manner of applying the surface of a globe to a plane; which Mr. WRIGHT, an Englishman, by an ingenious conception, happily accomplished.

He conceived the surface of this globe to swell like a bladder while it is blowing up from the equator towards the poles, proportionally in latitude as it does in longitude, until every part of its surface meets that of a concave cylinder impressed on it, whose diameter was equal to the globe's diameter. The equator being thus confined, the parts towards the poles must be extended, both in latitude and longitude, to fill up the cylinder or figure in the form of a rolling stone, and impress on its concave surface the lines drawn on the surface of the globe. This cylinder being cut on one of the meridians, from north to south, and laid open, would represent a true sea-chart, the parts of which bear the same proportion to one another as the corresponding parts of the globe do, and on which all the lines will be right lines; having every parallel of latitude on the globe increased till it is equal to the equator; and so the distance of the meridians in these parallels will become equal to their distance at the equators; consequently the meridians on the chart are expressed by parallel right lines.

Also, the meridians being lengthened as the parallels are increased, every degree of latitude is lengthened in the same proportion as the degrees of longitude are increased; therefore the distance of the parallels of latitude grow wider and wider as they approach the poles.

Mr. GERRARD MERCATOR, a Flemming, in 1556, published a similar chart; but in what manner it was constructed he did not show; neither were those degrees in their true proportion; whence called Mercator's Charts.

Mr. WRIGHT, in 1599, published the Principals of the True Sea Chart, and how to construct it on the following principles: viz.

That the distance between any two meridians at the equator is in proportion to their distance in any parallel of latitude, as the radius is to the co-sine of that latitude:

That any part of a parallel of latitude, is to a like part of the meridian, as the radius, is to the secant of that parallel:

And that the distance of any parallel of latitude from the equator is equal to the sum of the secants of all the arches between the equator and that parallel.

From these principles, Mr. WRIGHT set about forming a table, by the continual additions of secants, of all the parallels of latitude, beginning with 1 minute, which he made radius, and thereto adding the second parallel of 2 minutes, and to the sum of these two, the secant of 3 minutes, &c. The table thus formed, is that which is commonly called the Table of Meridional Parts, (see Table I.) by means of which a true nautical chart may be constructed, called Mercator's Chart, and all the Cases in WRIGHT'S, commonly called Mercator's Sailing, constructed and calculated.

As this table contains the meridional parts for every degree and minute of the quadrant, from the equator to the poles, it will be easy to find the meridional parts corresponding to any parallel of latitude, as for example :

Required the meridional parts corresponding to the latitude  $33^{\circ} 45'$ ?

Look in the top of the table for  $33^{\circ}$ , marked 33d, and in the right or left-hand columns, marked (M), under the degrees 33, and opposite the minutes 45 stands 2153, the meridional parts belonging  $33^{\circ} 45'$ .

When the given latitudes are both north or both south, the meridional difference of latitude is found by subtracting the meridional parts of the lesser latitude from those of the greater.

Required the meridional difference of latitude between the Lizard, in latitude  $49^{\circ} 57'$  N. and the Island of St. Mary's, in latitude  $37^{\circ}$  N.?

|                                                            |      |
|------------------------------------------------------------|------|
| The Lizard's latitude $49^{\circ} 57'$ N. meridional parts | 3470 |
| St. Mary's latitude $37^{\circ} 00'$ N. meridional parts   | 2393 |

Meridional difference of latitude 1077

When the latitudes are one north and the other south, the meridional difference of latitude is found, by adding the meridional parts corresponding to both the latitudes together.

Required the meridional difference of latitude between Cape Verd in latitude  $14^{\circ} 46'$  N. and the Cape of Good Hope, in latitude  $34^{\circ} 29'$  S.?

|                                                           |      |
|-----------------------------------------------------------|------|
| Cape Verd's latitude $14^{\circ} 46'$ N. meridional parts | 896  |
| Cape of Good Hope's $34^{\circ} 29'$ S. meridional parts  | 2207 |

Meridional difference of latitude 3103

The several cases in Mercator's Sailing are worked by geometry, trigonometry, Gunter's Scale, and the tables of difference of latitude and departure, exactly in the same manner as those in Plane Sailing,



Sailing, by only considering the meridional difference of latitude as if it was the proper difference of latitude, and the difference of longitude as the departure: for it is no more than enlarging the proper difference of latitude, so as to be equal to the meridional difference of latitude; then will the difference of longitude be the same proportion to the departure, that meridional difference of latitude does to the proper difference; for, in the following figure, (which is the first Case in Mercator's Sailing):

Let MT represent the meridional and MI the proper difference of latitude, TH the difference of longitude, IO the departure, MO the distance, and the angle TMH, or IMO the course; then will MI be in proportion to IO, as MT is to TH; and the contrary.

Wherefore, as the proper difference of latitude is to the departure, so is the meridional difference of latitude to the difference of longitude; and,

As the meridional difference of latitude is to the difference of longitude, so is the proper difference of latitude to the departure.

Since by lengthening or shortening the sides of a triangle does not alter the angles, the departure may be reduced into difference of longitude, and difference of longitude into departure.

In all the Cases (save the first) in Mercator's Sailing, the course, distance, difference of latitude and departure, are found in the same manner as those in Plane Sailing; and then the difference of longitude may be found by either of the following proportions viz. (See the opposite figure.)

|                                    |                                    |
|------------------------------------|------------------------------------|
| By making the enlarged Distance    | By making Meridional Difference    |
| MH Radius, it will be,             | of Latitude MT Radius, it will be, |
| As the co-sine of the course       | As radius                          |
| Is to the merid. diff. of latitude | Is to the merid. diff. of latitude |
| So is the sine of the course       | So is the tangent of the course    |
| To the diff. of longitude          | To the diff. of longitude          |

But in the First Case, it will be,

|                                |         |                                   |
|--------------------------------|---------|-----------------------------------|
| As the merid. diff. of lat. MT | } AND { | As radius                         |
| Is to radius                   |         | Is to the proper diff. of lat. MI |
| So is the diff. of long. TH    |         | So is the sec. of the course.     |
| To the tangent of the course;  |         | To the distance MO                |

Or, when the course is found, you may say, As the co-sine of the course is to the proper difference of latitude, so is radius to the distance.

CASE I.

*Latitudes and Longitudes of two Places given, to find the direct Course and Distance between them.*

Required the bearing and distance between the Lizard, in latitude  $49^{\circ} 57'$ , longitude  $5^{\circ} 14' W.$  and the Island of St. Mary's, one of the Western Islands, in latitude  $37^{\circ} N.$  and long.  $25^{\circ} 6' W.$

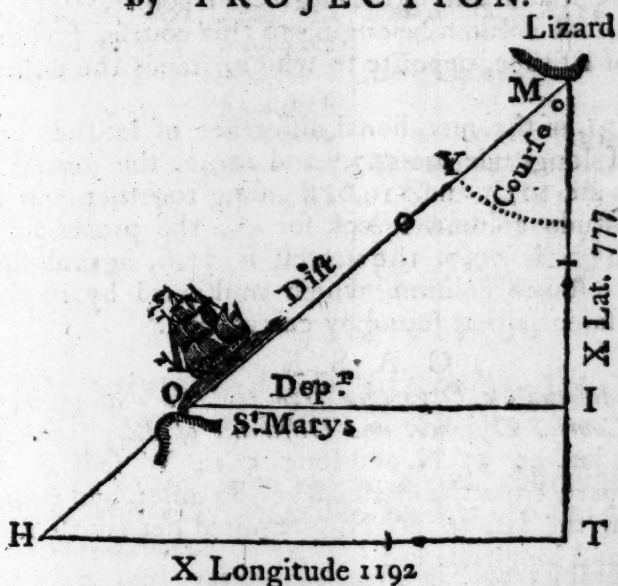
Lizard's lat.  $49^{\circ} 57' N.$  meridional parts 3470 lon.  $5^{\circ} 14' W.$

St. Mary's 37 0 N. meridional parts 2393 lon.  $25^{\circ} 6' W.$

Diff. of lat. 12 57 = 777

Diff. 1077 Diff. 19 52 = 1192

By PROJECTION.



Draw the meridian  $MT = 1077$ , the meridional difference of latitude, and  $MI = 777$ , the proper difference of latitude, perpendicular to  $MT$ ; draw  $TH$  and  $IO$ , make  $TH$  1192 miles, the difference of longitude, join  $H$  and  $M$ ; then will the angle  $MHT$  be the course  $S. 47^{\circ} 54' W.$  and  $OM$  the distance 1159 miles.

By CALCULATION.

To find the Course it will be,

|                               |          |
|-------------------------------|----------|
| mer. diff. of lat. 1077       | 3.03222  |
| radius 90                     | 10.00000 |
| diff. of long. 1192           | 3.07628  |
|                               | <hr/>    |
|                               | 13.07628 |
|                               | 3.03222  |
|                               | <hr/>    |
| ang. of cou. $47^{\circ} 54'$ | 10.04406 |

To find the Distance it will be,

|                                       |          |
|---------------------------------------|----------|
| As radius 90                          | 10.00000 |
| Is to prop. diff. lat. 777            | 2.89042  |
| So is sec. of course $47^{\circ} 54'$ | 10.17365 |
|                                       | <hr/>    |
|                                       | 13.06407 |
|                                       | 10.00000 |
|                                       | <hr/>    |
| To the dist. 1159                     | 3.06407  |

By

## By GUNTER.

1st. 'Extend from the meridional difference of latitude 1077, difference of longitude 1192, that extent will reach from radius or  $45^\circ$ , to the course  $47^\circ 54'$  on the line of tangents.'

2d. 'Extend from radius, or  $90^\circ$ , to the complement of course  $42^\circ 6'$  on the line of sines, that extent will reach from 777 to 1159 on the line of numbers.'

## By INSPECTION.

1st. Look for the meridional difference of latitude and difference of longitude, until they are found standing together in their respective columns (as if they were latitude and departure); and the course will be found among the degrees or points.

In the latitude column belonging to this course, find the proper difference of latitude, opposite to which, stands the distance in the column.

2d. Now  $\frac{1}{10}$  of the meridional difference of latitude and the difference of longitude are 107,7 and 119,2, the nearest numbers in the tables are 107,7 and 119,6, standing together over  $48^\circ$ .

In the latitude column I look for  $\frac{1}{10}$ , the proper difference of latitude, which is 77,7, the nearest is 77,6, against this stands 116 in the distance column, which multiplied by 10 gives 1160, nearly, the same as that found by calculation.

## C A S E II.

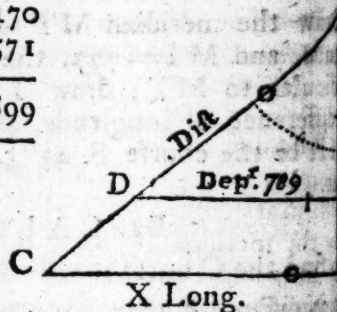
*Both Latitudes and the Departure from the Meridian given, to find Course, Distance, and Difference of Longitude.*

A ship in lat.  $49^\circ 57'$  N. and long.  $5^\circ 14'$  W sails S. westward until her depart. from the meridian be 789 miles, and then by observation is in the lat.  $39^\circ 20'$  N.; required her course steered, distance run, and longitude in?

Lat. left 49 57 Merid. parts 3470

Lat. in 39 20 Merid. parts 2571

Diff. of lat. 10 37 = 637 miles Diff. 899



## By PROJECTION.

With the proper difference of lat. and departure, project the same as in Case VI. in Plane Sailing; extend the meridian A B, and make A B equal to the meridional diff. of lat. and draw a line parallel to the departure D E; produce the distance A D to this parallel; and C B will be the difference of longitude. Hence the angle B A C will be the course, S.  $50^\circ 5'$  W. D A the distance 1014, and B C the difference of longitude 1114 miles.



To find the same by **C A L C U L A T I O N.**

As the P. diff. of lat. 637 2.80414  
 to Radius 90° 10.00000  
 is the departure 789 2.89708

12.89708  
 2.80414

To tang. course 51° 5' = 10.09294

As radius 90° 10.00303  
 to mer. diff. lat. 899 2.95376  
 is tang. course 51,5 10.09292

13.04668  
 10.00000

To diff. of long. 1114 3.04668

As radius 90° 10.00000  
 Is to diff. of lat. 637 2.80414  
 So is sec. course 51° 5' 10.20191

13.00605  
 10.00000

To the distance 1014 3.00605

Longitude left 5° 14' W.  
 Diff. of long. 1114 = 18 34 W.

Longitude in 23 48 W.

Her course is S. 51° 5' W. and  
 distance 1014 miles.

**NOTE.** The diff. of long. may be  
 found by saying, As prop. diff. of  
 lat. : dep. :: merid. diff. of Lat. :  
 diff. of long.

By **G U N T E R.**

1st. 'The extent from diff. lat. 637, to dep. 789, on the line of numbers, will reach from radius, or 45°, to 51° 5', the course on the line of tangents.'

2dly. 'The extent from radius to com. course 38° 55', on the line of sines, will reach from diff. lat. 637, to 1014, the distance on the line of numbers.'

3dly. 'The extent from co-course 38° 55' to fine course 51° 5' on the line of sines, will reach from merid. diff. lat. 899, to 1114 the difference of longitude on the line of numbers.'

By **I N S P E C T I O N.**

The diff. of lat. and dep. being found together in their respective columns will give the course among the degrees or points, and the dist. in its column: in the lat. column belonging to the course, look for the meridional diff. of lat. and against it will stand the difference of long. in the departure column.

Now  $\frac{1}{6}$  of diff. of latitude and of dep. are 106,1 and 131,5, the nearest numbers to these are 106,4 and 131,3, standing together over 51° the course, and against dist. 169; this multiplied by 6, gives 1014 the distance.

Again, over 51° look for  $\frac{1}{10}$  of merid. diff. of lat. 89,9 in the lat. column, the nearest is 90, and against which stand 111,1 in the dep. column; this multiplied by 10, gives 1111 for the diff. of longitude.

N

C A S E

## C A S E III.

*Both Latitudes and Course given, to find the Distance and Difference of Longitude.*

A ship from the Lizard makes her course S.  $39^{\circ}$  W. and then by observation is in latitude  $45^{\circ} 31' N$ ; required her distance run, and longitude in?

Lat. of the Lizard  $49^{\circ} 57' N$ . Mer. parts 3470

Lat. by obser.  $45^{\circ} 31' N$ . Mer. parts 3070

Diff.  $426 = 266$  m. diff. 396M.



## By PROJECTION.

Draw a meridian AB, the upper end A will represent the ship's place in her first latitude.

Take the proper difference of latitude 266 in your compasses, and with one foot in A, the ship's place, lay the other upon the meridian; from A to E, take the merid. diff. of latitude 396 in your compasses, and with one foot in A, the ship's place, as before, lay the other upon the meridian at B; and upon these two points raise the perpendiculars DE and CB; a line drawn from the ship's place, making an angle with the meridian equal to  $39^{\circ}$  the ship's course, will cut the two perpendiculars at D and C; the first will be the departure, which terminates the distance AD 342, and the other will be the difference of longitude CB = 321 miles.

From what has been said, it is plain, that any case in Mercator's Sailing may be projected as a right-angled triangle, by only considering the difference of longitude, or departure, as the base; the meridional, or proper difference of latitude, as the perpendicular; the hypotenuse cut by the departure as distance; and the angle which that makes with the perpendicular, the course; for in all cases in Mercator's Sailing, the meridional difference of latitude bears the same proportion to the difference of longitude, that the proper difference of latitude does to the departure.

These instructions being well understood, will be sufficient to inform the Learner how to construct any of the following cases:

By

By CALCULATION.

To find the Distance.

As the co-sine course  $39^\circ$  9.89050  
 Is to the diff. of lat. 266 2.42488  
 So is radius 10.00000

12.42488  
 9.89050

So the distance 342,3 2.53438

To find the diff. of Longitude.

As the co-si. course  $39^\circ$  9.89050  
 Is to mer. diff. of lat. 396 2.59770  
 So is S. course  $39^\circ$  9.79887

12.39657  
 9.89050

To the diff. of lon. 320,7 2.50607

Longitude left

$5^\circ 14' W.$

Difference of long. 321; or

$5^\circ 21' W.$

Longitude in

$10^\circ 35' W.$

By GUNTER.

1st. 'The extent from co-sine course  $51^\circ$ , to radius on the line of sines, will reach from the proper difference of latitude 266, to the distance 342,3 on the lines of numbers.'

2dly. 'The extent from co-sine course  $51^\circ$ , to sine course  $39^\circ$  on the line of sines, will reach from the meridian difference of latitude 396, to the difference of longitude 321, on the line of numbers.'

By INSPECTION.

Under the course  $39^\circ$ , and against half the diff. of lat. 133, stands 171 in the distance column, which being doubled is 342, the distance; under the same degrees, and in the latitude column, look for half the meridian difference of latitude 198, against that, in the departure column, stands 160,5, doubled is 321, the difference of longitude nearly, as before.

CASE IV.

*The Latitude, Course, and Distance given, to find the Difference of Latitude, and Difference of Longitude.*

A ship in latitude  $42^\circ 30' N.$  and longitude  $18^\circ 31' W.$  sails S. by S. 59 miles; I demand the latitude and longitude the ship is in?



To find the Diff. of Latitude it will be,

|                            |          |           |         |              |        |
|----------------------------|----------|-----------|---------|--------------|--------|
| As radius                  | 10.00000 | Lat. left | 42° 30' | M. parts.    | { 2822 |
| Is to the distance 591     | 2.77159  | Dif. lat. | 491.8   |              | { 2194 |
| So is co-fi. course 3 pts. | 9.91985  | Lat. in   | 34 19   | M. dif. lat. | 628    |
|                            | 12.69144 |           |         |              |        |
|                            | 10.00000 |           |         |              |        |

To the diff. of lat. 491.4 2,69144

To find the Diff. of Long. it will be,

|                        |          |           |                 |
|------------------------|----------|-----------|-----------------|
| As co-fi. cou. 3 pts.  | 9.91785  | Lon. left | 18° 31' W.      |
| Is to m. dif. lat. 628 | 2.79796  | Di. la.   | 420 = 7° 00' W. |
| So is S. course 3 pts. | 9.74474  | Long. in  | 25 31 W.        |
|                        | 12.54270 |           |                 |
|                        | 9.91985  |           |                 |

To diff. long. 419.6 2.62285

By GUNTER.

1st. 'The extent from radius to 5 points, the com. of the course on the line marked S R, will reach from the distance 591 to the difference of latitude 491,4, on the line of numbers.'

2dly. 'The extent from co-course 5 points, to the course 3 points on the line marked S R, will reach from the meridian difference of latitude 628, to the difference of longitude 419,6, on the line of numbers.'

By I N S P E C T I O N .

Under the course 3 points, and opposite a tenth of the distance 59, in the latitude column, stands 49,1, which multiplied by 10 is 491, the difference of latitude; then find  $\frac{1}{4}$  of the meridian difference of latitude 157, in the latitude column, against which stand 105 in the departure column, which multiplied by 4, gives 420 the difference of longitude.

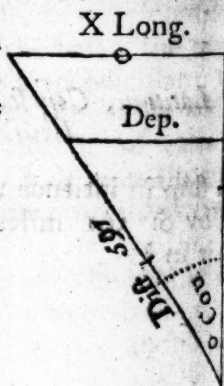
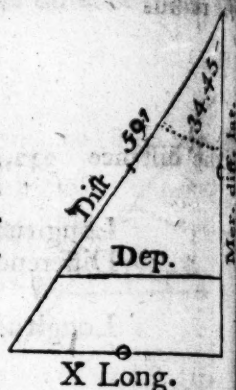
C A S E V.

Both Latitudes and Distance given, to find the Course and Difference of Longitude.

If a ship runs 300 miles N. Westerly from a port in latitude 37' N. and longitude 10° 25' W. until she be in latitude 41' N.; required the course steered and longitude in?

|           |       |              |      |
|-----------|-------|--------------|------|
| Lat. left | 37 N. | Merid. parts | 2393 |
| Lat. in   | 41 N. | Merid. parts | 2702 |

Diff. 4 = 240 M. diff. 309 M.



By CALCULATION.

To find the Course.

|                               |          |
|-------------------------------|----------|
| As the distance 300           | 2.47712  |
| Is to radius                  | 10.00000 |
| So is prop. diff. of lat. 240 | 2.38021  |
|                               | <hr/>    |
|                               | 12.38021 |
|                               | 2.47712  |
|                               | <hr/>    |

To find the Diff. of Longitude.

|                                  |          |
|----------------------------------|----------|
| As co-fi. cou. $36^{\circ} 52'$  | 9.90311  |
| Is to mer. diff. of lat. 309     | 2.48996  |
| So is fine cou. $36^{\circ} 52'$ | 9.77812  |
|                                  | <hr/>    |
|                                  | 12.26808 |
|                                  | 9.90311  |
|                                  | <hr/>    |

To the co-fi. cou.  $36^{\circ} 52'$  9.90309 To the diff. of long. 231.7 2.36497

Longitude left  $10^{\circ} 25' W.$

Diff. of longitude 231, or  $3 51 W.$

Longitude in  $14 16$

By GUNTER.

1st. 'The extent from the distance 300, to the proper difference of latitude 240, on the line of numbers, will reach from radius or  $90^{\circ}$ , to  $53^{\circ} 8'$  the complement of the course, on the line of fines.'

2d. 'The extent from co-course,  $53^{\circ} 8'$ , to course  $36^{\circ} 52'$ , on the line of fines, will reach from the meridian difference of latitude 309, to the difference of longitude 231.7, on the line of numbers.'

By INSPECTION.

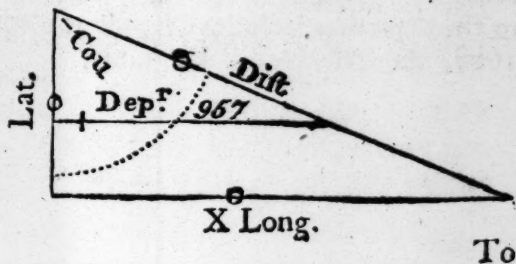
With the distance and difference of latitude find the course; then, in the latitude column belonging to this course, find the meridian difference of latitude; against which, in the departure column, will stand the difference of longitude.

Thus, half the distance 150, and half the difference of latitude 120, will be found standing together in their columns, nearly under  $37^{\circ}$ , the course; and in the latitude column, find half the meridian difference of latitude 154.5, the nearest to it is 154.1; against which, in the departure column, stands 116.1, which doubled is 232.2, the difference of longitude nearly, as before.

CASE VI.

One Latitude, Course, and Departure given, to find the Distance, Difference of Latitude, and Difference of Longitude.

A ship sails E. S. E. from a certain port in latitude  $50^{\circ} 10'$  S. and longitude  $10^{\circ} 16'$  E. until her departure from the meridian be 957 miles; I demand the distance sailed, and the latitude and longitude she is in?



|                                  |          |                                         |                     |
|----------------------------------|----------|-----------------------------------------|---------------------|
| To find the Distance it will be, |          | To find the Diff. of Lat. it will be,   |                     |
| As the fine cou. 6 pts.          | 9.96562  | As fine cou. 6 pts                      | 9.96562             |
| Is to the departure 957          | 2.98091  | Is to departure 957                     | 2.98091             |
| So is radius                     | 10.00000 | So is co-fi. cou. 6 pts.                | 9.58284             |
|                                  | <hr/>    |                                         | <hr/>               |
|                                  | 12.98091 |                                         | 12.56375            |
|                                  | 9.96562  |                                         | 9.96562             |
|                                  | <hr/>    |                                         | <hr/>               |
| To the distance 1036             | 3.01529  | To diff. of lat. $396=6^{\circ} 36'$    | 2.59813             |
| To find the Diff. of Longitude.  |          | Lat. left $50^{\circ} 10'$ S. mer. pts. |                     |
| As co-fi. cou. 6 pts.            | 9.58284  | Lat. in $56^{\circ} 46'$ S. mer. pts.   | 4157                |
| Is to mer. diff. of lat. 667     | 2.82413  |                                         | <hr/>               |
| So is fi. cou. 6 pts.            | 9.96562  | Merid. difference                       | 667                 |
|                                  | <hr/>    |                                         | <hr/>               |
|                                  | 12.78975 | Long. left                              | $10^{\circ} 16'$ E. |
|                                  | 9.58284  | Diff. of longitude $1610=26$            | 50 E.               |
|                                  | <hr/>    |                                         | <hr/>               |
| To diff. of long. 1610           | 3.20691  | Longitude in                            | 37 6 E.             |

## By G U N T E R.

1st. 'The extent from 6 points, to radius on the line marked SR, will reach from the departure 957, to the distance 1036, on the line of numbers.'

2dly. 'The extent from 6 points to 2 points, on the line marked SR, will reach from the departure 957, to the difference of latitude 396, on the line of numbers.'

3dly. 'The extent from 2 points to 6 points, on the line marked SR, will reach from the meridian difference of latitude 667, to the difference of longitude 1610, on the line of numbers.'

## By I N S P E C T I O N.

Over the course of 6 points, and against a fifth of the departure 191,4, stands 79,2 and 207, which multiplied by 5 gives 396, the difference of latitude, and 1035 for the distance.

Then, in the latitude column, find a tenth of the meridian difference of latitude 66,7, the nearest to that is 66,6; against which, in the departure column, stands 160,8, which multiplied by 10 is 1608, the difference of longitude.

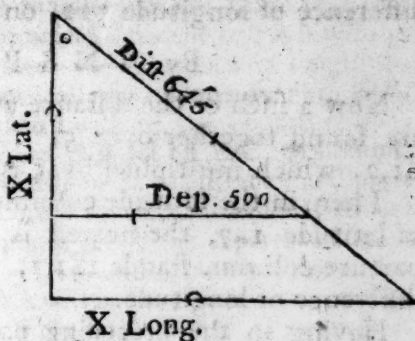
C A S E



CASE VII.

Given the Latitude, Distance sailed, and Departure from the Meridian given, to find the Course, Difference of Latitude, and Difference of Longitude.

A ship in latitude  $49^{\circ} 30' N.$  and longitude  $14^{\circ} 40' W.$  sails S. eastward 645 miles, until her departure from the meridian be 500 miles. Required the course steered, and the latitude and longitude she is in?



To find the Course it will be,  
As the distance 645 2.80956  
To radius  $90^{\circ}$  10.00000  
So is departure 500 2.69897

12.69897  
2.80956

To fine course  $50^{\circ} 50'$  9.88941

To find the Diff. of Long. it will be,  
As co-fi. cou.  $50^{\circ} 50'$  9.80043  
To m. diff. of lat. 588 2.76938  
So is fine course  $50^{\circ} 50'$  9.88948

12.65886  
9.80043

To dif. lon.  $721,8 = 12 \ 2 \ 2.85843$   
Long. left 14 40

Long. in 2 38 W.

To find the Diff. of Lat. it will be,  
As fine cou.  $50^{\circ} 50'$  9.88948  
Is to departure 500 2.69897  
So is co-fi. cou.  $50^{\circ} 50'$  9.80043

12.49943  
9.88948

To diff. lat.  $407,3 = 6^{\circ} 47'$  2.60992

Lat. left  $49^{\circ} 30' N.$  M. pts. 3428  
Lat. in  $42 \ 43 \ N.$  M. pts. 2840

Merid. diff. lat. 588

As pro. diff. of lat. 407,3 2.60992  
Is to departure 500 2.69897  
So is m. dif. of lat. 588 2.76938

5.46835  
2.60992

To dif. of long. 721,8 2.85843

Hence the ship's course is S.  $50^{\circ} 50' E.$  or S. E.  $\frac{1}{2}$  east nearly, and she is in the latitude of  $42^{\circ} 43' N.$  and long.  $2^{\circ} 38' W.$

By G U N T E R.

1st. 'The extent from the distance 645, to the departure 500 on the line of numbers, will reach from radius to  $50^{\circ} 50'$ , on the line of fines.'

2dly.

2dly. 'The extent from  $50^{\circ} 50'$  to  $39^{\circ} 10'$ , on the line of fines, will reach from the departure 500, to the difference of latitude 407, on the line of numbers.'

3dly. 'The extent from  $39^{\circ} 10'$  to  $50^{\circ} 50'$ , on the line of fines, will reach from the meridian difference of latitude 588, to the difference of longitude 722, on the line of numbers.'

### By I N S P E C T I O N .

Now a fifth of the distance and departure are 129 and 100, and are found together over  $51^{\circ}$ ; and in the latitude column stands 81,2, which multiplied by 5 is 406, the difference of latitude.'

Then, in the latitude column, seek  $\frac{1}{4}$  of the meridional difference of latitude 147, the nearest is 146,6; against which, in the departure column, stands 181,1, which multiplied by 4 is 724,4, the difference of longitude.

Having in the preceding parts shewn how to work the most useful problems in Middle Latitude and Mercator's Sailing; shall now work the four following cases both by Middle Latitude and Mercator's Sailings, in the manner I generally teach persons who are of age, and youth of good abilities; especially if they are limited to a short time; and I believe they are all that can well happen at sea.

*The following four Cases are worked by Middle Latitude and Mercator's Sailing.*

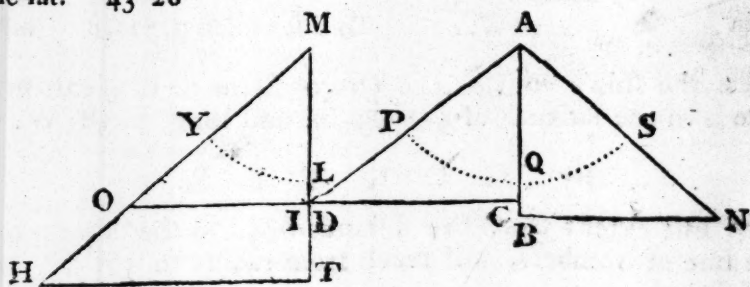
Required the bearing and distance between the Lizard in latitude  $49^{\circ} 57' N.$  longitude  $5^{\circ} 14' W.$  and the Island of St. Mary's, one of the western islands, in latitude  $37^{\circ} N.$  and longitude  $25^{\circ} 6' west$ ?

Lizard's lat.  $49^{\circ} 57' N.$  Merid. pts. 3470 Lon.  $5^{\circ} 14' W.$   
 St. Mary's lat.  $37^{\circ} N.$  Merid. pts. 2393 Lon.  $25^{\circ} 06' W.$

Diff. of lat.  $12\ 57 = 777$  miles. Diff.  $1077$  Diff.  $19\ 52 = 1192$  miles.

Sum lat.  $2)86\ 57$

Middle lat.  $43\ 28$



By

By PROJECTION.

By Mercator's Sailing.

Draw the meridian  $MT = 1077$  the meridian diff. of lat. and  $MI = 777$  the proper diff. of lat. perpendicular to  $MT$  draw  $TH$  and  $IO$ . Make  $TH = 1192$  miles, the difference of longitude. Join  $H$  and  $M$ , then will the angle  $THM$  be course  $S. 47^{\circ} 54' W.$  and  $OM$  the distance  $1159$  miles.

By Middle Latitude Sailing.

Draw the meridian  $AB$ , with the chord of  $60^{\circ}$  describe the arch  $PS$ , upon which set off  $46^{\circ} 32'$  the com. of middle latitude from  $Q$  to  $S$ ; through  $S$  draw the line  $AN = 1192$  miles, the difference of longitude. Let fall the perpendicular  $NB$ , which will be the departure  $865$ . Upon  $AB$  set off  $AC = 777$  miles, the difference of latitude; and upon  $C$  erect the perpendicular  $CD$ , and upon it set off the departure  $865$ .

Join  $D$  and  $A$ , and it is done; for  $DA$  will be the distance  $1163$  miles, and the angle  $CAD$  the course  $S. 48^{\circ} 4' W.$

By CALCULATION.

By Mid. Lat. Sailing.

As radius  $90^{\circ}$  10.00000  
Is to diff. of long.  $1192$  3.07628  
So is co-fi. m. lat.  $43^{\circ} 28'$  9.86080

12.93708  
10.00000

To the departure  $865, 1 = 2.93708$

As diff. of lat.  $777$  2.89042  
Is to radius  $90^{\circ}$  10.00000  
So is the departure  $865, 1$  2.93708

12.93708  
2.89042

To tang. of course  $48^{\circ} 4'$  10.04666

As radius 10.00000  
Is to the diff. of lat.  $777$  2.89042  
So is the sec. course  $48^{\circ} 4'$  10.17505

13.06547  
10.00000

To the distance  $1163$  3.06547

By Mercator's Sailing.

As the m. dif. of lat.  $1077$  3.03222  
Is to radius  $90^{\circ}$  10.00000  
So is the dif. of long.  $1192$  3.07628

13.07628  
3.03222

Tang. of cou.  $47^{\circ} 54'$  10.04406

As radius 10.00000  
Is to the p. dif. of lat.  $777$  2.89042  
So is sec. of cou.  $47^{\circ} 54'$  10.17365

13.06407  
10.00000

To the Dist. in miles  $1159$  3.06407

NOTE. The Course may be found by Mid. Lat. Sailing without the Departure; thus,

As diff. of lat.  $777$  2.89042  
Is to diff. of long.  $1192$  3.07628  
So is co-fi. m. lat.  $43^{\circ} 28'$  9.86080

12.93708  
2.89042

To tang. course  $48^{\circ} 4'$  10.04666

By



## By GUNTER.

## By MIDDLE LATITUDE SAILING.

1st. 'Extend from radius or  $90^{\circ}$ , to  $46^{\circ} 32'$  the comp. mid. lat. on the line of fines, that extent will reach from the diff. of long. 1192, to the dep. 865, on the line of numbers.'

2dly. 'Extend from the diff. of lat. 777 to the dep. 865, on the line of numbers, that extent will reach from radius or  $45^{\circ}$ , to the course  $48^{\circ} 4'$ , on the line of tangents.'

3dly. 'Extend from the course  $48^{\circ} 4'$ , to radius or  $90^{\circ}$ , on the line of fines, that extent will reach from the departure 865, to the distance 1163 miles, on the line of numbers.'

## By MERCATOR.

1st. 'Extend from merid. diff. of lat. 1077, to diff. of longitude 1192 on the line of numbers, that extent will reach from radius or  $45^{\circ}$ , to the course  $47^{\circ} 54'$ , on the line of tangents.'

2dly. 'Extend from radius or  $90^{\circ}$ , to the comp. of  $42^{\circ} 6'$  on the line of fines, that extent will reach from the prop. diff. of lat. 777 to the dist. 1159, on the line of numbers.'

## By INSPECTION.

## By MIDDLE LATITUDE SAILING.

Look for the comp. of mid. latitude, as if it was a course in Plane Sailing, and difference of longitude in the distance column, opposite to which will stand the departure in its column. Having the difference of latitude and departure, the course and distance is found as in Case VI. in Plane Sailing.

Thus, taking  $\frac{1}{4}$  of the difference of longitude  $1192 = 298$ , and as the comp. of middle latitude is  $46^{\circ} 32'$  or nearly  $46\frac{1}{2}$ ; I look over  $46^{\circ}$  and  $47^{\circ}$ , and against distance 298 stands 214.4 and 218 in the departure columns; which added together, gives 432.4 half is 216.2, this multiplied by 4, because the difference of longitude was divided by 4, gives 864.8, the departure: Again, taking  $\frac{1}{4}$  of the difference of latitude, and  $\frac{1}{4}$  of the departure 194.2 and 216.2, the nearest numbers to these standing together are 216.2 and 194.7, over  $48^{\circ}$  and against the distance 291; this multiplied by 4 gives the distance 1164 miles. Hence the course is S.  $48^{\circ}$  W. and distance 1164 miles.

## By MERCATOR.

1st. Look for the meridian difference of latitude and difference of longitude, until they are found standing in their respective columns, (as if they were latitude and departure) and the course will be found among the degrees or points, in the latitude column; belonging to this course, find the proper difference of latitude, opposite to which stands the distance in its column.

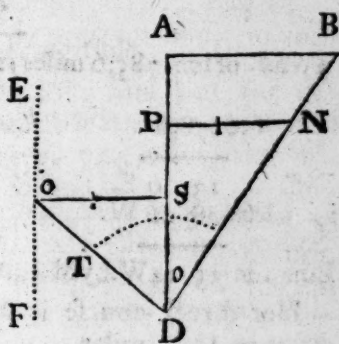
Now

Now  $\frac{1}{10}$  of the meridian difference of latitude, and the  $\frac{1}{10}$  of the difference of longitude are 107,7 and 119,2, the nearest numbers in the tables are 107,7 and 119,6 standing together over  $48^\circ$ , which is the course; over  $48^\circ$  in the latitude column, I look for the  $\frac{1}{10}$  of the proper difference of latitude, which is 77,7, the nearest is 77,6, against this stands 116 in the distance column, which multiplied by 10, gives 1160 the distance nearly, as before.

*The Difference of Latitude and Departure given, to find the Course, Distance, and Difference of Longitude, by Middle Latitude and Mercator's Sailing*

A ship from the latitude of  $37^\circ$  N. and longitude  $48^\circ 20'$  W. sails between the north and east, until she be in latitude  $51^\circ 15'$  N. and finds that she has made 564 miles of departure; what was her direct course, distance run, and longitude in?

|                        |                         |                   |             |
|------------------------|-------------------------|-------------------|-------------|
| Lat. left              | $37^\circ 0' \text{N.}$ | Mer. parts        | 2393        |
| Lat. in                | $51 15 \text{N.}$       | Mer. parts        | 3593        |
|                        | <u>14 15</u>            | = 855 miles Diff. | <u>1200</u> |
| Sum lat. $\frac{1}{2}$ | <u>88 15</u>            |                   |             |
| Mid. lat.              | <u>44 7</u>             |                   |             |
|                        |                         | $90^\circ$        |             |
|                        |                         | <u>44 7</u>       |             |
| Comp. mid. lat.        |                         | 45 53             |             |



Draw the meridian DP, make it equal to 855 the difference of latitude; on P erect the perpendicular PN, and make it=564 the departure; join D and N, then will the angle PDN be the course N.  $33^\circ 25'$  W. and DN the distance 1025 miles.

At the distance of the departure 564, draw EF parallel to DP; with the chord of  $60^\circ$  describe the arch TS, and upon it set off the comp. of the middle latitude  $45^\circ 53'$  from S to T, through T draw DO, to cut EF in O, then will OD be the difference of longitude 785,6 miles, by Middle Latitude Sailing.

Again, produce DP to A, and make DA = 1200 the merid. difference of latitude; draw AB parallel to PN, and produce DN until it cuts AB in B; then will AB be 791,7 miles; the difference of longitude by Mercator's Sailing.

## By CALCULATION.

|                          |          |                             |          |
|--------------------------|----------|-----------------------------|----------|
| As the diff. of lat. 855 | 2.93197  | As radius 90°               | 10.00000 |
| Is to radius 90°         | 10.00000 | Is to the diff. of lat. 855 | 2.93197  |
| So is the departure 564  | 2.75128  | So is sec. course 33° 25'   | 10.07848 |
|                          | 12.75128 |                             | 13.01045 |
|                          | 2.93197  |                             | 10.00000 |
| To tang. of cou. 33° 25' | 9.81931  | To the distance 1025        | 3.01045  |

To find the Difference of Longitude,

By Middle Latitude Sailing.

|                            |          |
|----------------------------|----------|
| As co-fi. mid. lat. 44° 7' | 9.85608  |
| Is to departure 564        | 2.75128  |
| So is radius 90°           | 10.00000 |
|                            | 12.75128 |
|                            | 9.85608  |

To dif. of lon. 785,6 miles 2.89520

By Mercator's Sailing.

|                             |          |
|-----------------------------|----------|
| As co-fi. cou. 33° 25'      | 9.92152  |
| Is to mer. dif. lat. 1200   | 3.07918  |
| So is the fine cou. 33° 25' | 9.74093  |
|                             | 12.82011 |
|                             | 9.92152  |

To dif. of lon. 791,7 ms. 2.89859

6,0)78,6

Diff. 13 6 E.  
Lon. left. 48 20 W.

Long. in 35 14 W. by M. Lt. Sailing.

6,0)792

Diff. lon. 13 12 E.  
Lon. left 48 20 W.

Long. in 35 8 W. by Mer. Sail.

Her direct course is N. 33° 25' E. or N. E. by N. nearly, and distance 1025 miles.

## By GUNTER.

1st. 'Extend from 855 to 564 on the line of numbers, that extent will reach from radius or 45°, to 33° 25' the course, on the line of tangents.'

2dly 'Extend from radius or 90°, to the course 33° 25' on the line of sines, that extent will reach from the departure 564, to the distance 1025, on the line of numbers.'

3dly. 'Extend from radius or 90°, to the complement of middle latitude 45° 53' on the line of sines, that extent will reach from the departure 564, to 785 miles, the difference of longitude by Middle Latitude Sailing.'

4thly. 'Extend from the sine of the course 33° 25' to the cosine of the course 56° 35' on the line of sines, that extent will reach from the meridional difference of latitude 1200 to 792 miles, the difference of longitude by Mercator.'

'Or, the extent from the difference of latitude 855, to the departure 564, will reach from the meridional difference of latitude 1200, to 792, on the line of numbers.'

By



By INSPECTION.

With the difference of latitude and departure, find the course and distance as in Case VI. in Plane Sailing. Take the complement of middle latitude as a course, and the departure in its column, the corresponding distance will be the difference of longitude, by Middle Latitude Sailing. And,

Having found the course, instead of the proper difference of latitude, find the meridional difference of latitude in the latitude column belonging to the course; the corresponding departure will be the difference of longitude, by Mercator's Sailing.

Now taking  $\frac{1}{10}$  of the difference of latitude,  $\frac{1}{10}$  of the departure, viz. 85,5 and 56,4, the nearest numbers standing together in the tables to these are, 85,5 and 55,5, under  $33^\circ$  against distance 102, and 85,4 and 57,6, under  $34^\circ$  against distance 103; now  $33^\circ$  added to  $34^\circ$  is 67, half is  $33^\circ 30'$  the course; and 102 added to 103 gives 205, half is 102,5, which multiplied by 10, gives 1025 the distance.

To find the Difference of Longitude.

Over the complement of middle latitude  $46^\circ$ , find  $\frac{1}{4}$  of the departure, viz. 141 in its column, and against it stands 196 in the distance column, this multiplied by 4, gives 784 miles, the difference of longitude, by Middle Latitude Sailing.

Again, the course being  $33^\circ 25'$  or nearly  $33^\circ \frac{1}{2}$ , look for  $\frac{1}{10}$  of meridional difference of latitude = 120 in the latitude columns, under  $33^\circ$  and  $34^\circ$ , the nearest numbers to these are 110,9 and 120,2, the departures corresponding are 77,9 and 81,1, their sum is 159, half is 79,5, which multiplied by 10, gives 795 the difference of longitude, by Mercator's Sailing, nearly, as before.

From what has been said, it is easy to perceive that all the Cases (save the first) in Middle Latitude and Mercator's Sailing, are projected and worked in the same manner as in Plane Sailing, and to obtain the difference of longitude by Middle Latitude Sailing, the complement of the middle latitude is taken as a course in Plane Sailing, and with this course and the departure, the distance is found, which will be the difference of longitude by Middle Latitude Sailing. And having the course, take the meridional difference of latitude, as if it was the proper difference of latitude, the corresponding departure will be the difference of longitude by Mercator's Sailing.

*The Course and Distance given, to find the Difference of Latitude, and Difference of Longitude.*

A ship from Cape Clear, in latitude  $51^\circ 15' N.$  and longitude  $9^\circ 50' W.$  sails S. W. by S. until she has run 1022 miles, what latitude and longitude is she in?

As

|                          |          |
|--------------------------|----------|
| As radius 90°            | 10.00000 |
| Is to the distance 1022  | 3.00945  |
| So is fine course 3 pts. | 9.74474  |
|                          | <hr/>    |
|                          | 12.75419 |
|                          | 10.00000 |

To the departure 567,8 2,75419

|                          |          |
|--------------------------|----------|
| As radius 90°            | 10.00000 |
| Is to the distance 1022  | 3.00945  |
| So is co-fine co. 3 pts. | 9.91985  |
|                          | <hr/>    |
|                          | 12.92930 |
|                          | 10.00000 |

To the diff. of lat. 849,8 2.92930

Now 849,8, or 850 divided by 60, gives  $14^{\circ} 10'$  S. and being subtracted from the latitude of Cape Clear, leaves  $37^{\circ} 5'$  the latitude in: Hence the middle latitude is found to be  $44^{\circ} 10'$ , and meridional difference of latitude 1194. Whence,

To find the Difference of Longitude by Mid. Lat. Sailing.

|                                     |          |
|-------------------------------------|----------|
| As co-fine m. lat. $44^{\circ} 10'$ | 9.85571  |
| Is to the departure 567,8           | 2.75420  |
| So is radius 90°                    | 10.00000 |
|                                     | <hr/>    |
|                                     | 12.75420 |
|                                     | 9.85571  |

To the diff. of lon. 791,6 2.89849

Cape Clear's long.  $9^{\circ} 50'$  W.  
Diff. of long. 792 = 13 12 W.

Lon. in by mid. lat. = 23 2 W.

To find the Difference of Longitude by Mercator's Sailing.

|                               |          |
|-------------------------------|----------|
| As the co-fi. course 3 pts.   | 9.91985  |
| Is to mid. diff. of lat. 1194 | 3.07700  |
| So is fine course 3 pts.      | 9.74474  |
|                               | <hr/>    |
|                               | 12.82174 |
|                               | 9.91985  |

To the diff. of lon. 797,8 2.90189

Cape Clear's long.  $9^{\circ} 50'$  W.  
Diff. of long. 978 = 13 18 W.

Long. in, by Mercator, 23 8 W.

*The Course and Difference of Latitude given, to find the Distance and Difference of Longitude.*

A ship in  $37' N.$  and longitude  $22^{\circ} 56' W.$  fails N.  $22^{\circ} 20' E.$  for several days, and then by observation is found to be in the latitude  $51^{\circ} 15' N.$ ; required the distance run and longitude in?

|                       |                   |
|-----------------------|-------------------|
| Lat. $51^{\circ} 15'$ | Merid. Parts 3593 |
| Lat. 37               | Merid. Parts 2393 |

Diff. 14 15 = 855 miles

1200 = merid. diff. of lat.

Sum  $\frac{1}{2}$  88 15 = 44,7 mid. lat.

|                                    |          |
|------------------------------------|----------|
| As co-fine course $22^{\circ} 20'$ | 9.96614  |
| Is to diff. of lat. 855            | 2.93197  |
| So is fine course $22^{\circ} 20'$ | 9.57978  |
|                                    | <hr/>    |
|                                    | 12.51175 |
|                                    | 9.96614  |

To the departure 351,3 2.54561

|                                  |          |
|----------------------------------|----------|
| As co-fine cou. $22^{\circ} 20'$ | 9.96614  |
| Is to diff. of lat. 855          | 2.93197  |
| So is radius 90°                 | 10.00000 |
|                                  | <hr/>    |
|                                  | 12.93197 |
|                                  | 9.96614  |

To the distance 924,3 2.96583

To

To find the Difference of Longitude,

By Mid. Lat. Sailing.

As co-fine mid. lat.  $44^{\circ} 7'$  9.85608  
Is to the departure  $351'$  32.54561  
So is radius  $90^{\circ}$  10.00000

12.54561  
9.85608

To dif. l.  $489 = 8^{\circ} 9' E.$  2.68953  
Lon. left  $22 \quad 56 W.$

Long. in  $14 \quad 47 W.$  by m. lat.

By Mercator's Sailing.

Co-fi. course  $22^{\circ} 20'$  9.96614  
Is to mid. dif. of lat. 1200 3.07918  
So is fine course  $22^{\circ} 20'$  9.57978

12.65896  
9.96614

To dif. lon.  $493 = 8^{\circ} 13'$  2.69282  
Long. left  $22 \quad 56$

Long. in  $14 \quad 43 W.$  by Mer.

These four cases are all that can well happen at sea; but as some young men are inattentive, and frequently looking in the book to see if their calculation is the same as that set down;

The Teacher perhaps may find it necessary to let such work the following questions by way of exercise:

*Quest.* 1st. Required the bearing and distance of Hang. Cliff in Shetland, in latitude  $60^{\circ} 9' N.$  and long.  $58' W.$  and the North Cape of Lapland, in lat.  $71^{\circ} 10' N.$  long.  $26^{\circ} 3' E.$ ?

*Ans.* {  $N. 44^{\circ} 48' E.$  dist. 938,5 miles, by Mercator's Sailing.  
           $N. 45^{\circ} 19' E.$  dist. 940 miles, by Middle Lat. Sailing.

*Quest.* 2d. A ship in lat.  $37^{\circ} N.$  and longitude  $48^{\circ} 20' W.$  sails between the N. and E. until she is in the latitude of  $51^{\circ} 18' N.$  and finds she has made 564 miles of dep.; required her direct course, and distance run, and longitude in?

*Ans.* {  $N. 33^{\circ} 19' E.$  dist. 1027 miles, long. in  $35^{\circ} 14' W.$  by  
          Middle Latitude Sailing.  
           $N. 33^{\circ} 19' E.$  dist. 1027 miles, long. in  $35^{\circ} 8'$ , by Mer-  
          cator's Sailing.

*Quest.* 3d. A ship from the lat. of  $50^{\circ} 30' N.$  sails S. S. W. 150 leagues; what lat. is she in, and how much has she differed her longitude?

*Ans.* { Lat. in  $43^{\circ} 34' N.$  diff. of long. 253,3 miles, by Mercator's  
          Sailing.  
          Lat. in  $43^{\circ} 34' N.$  diff. of long. 252,6 miles, by Middle  
          Latitude Sailing.

*Quest.* 4th. A ship from latitude  $20^{\circ} 40' N.$  sails N. E. by E. until she be in the latitude of  $27^{\circ} 16' N.$ ; required her distance run, and difference of longitude?

*Ans.* { Distance run 712,8 miles, difference of longitude 648,1  
          miles, by Mercator.  
          Distance run 712,8 miles, difference of longitude 648,6  
          miles by Middle Latitude.

*Quest.*



*Quest. 5th.* Suppose a ship from the latitude of  $45^{\circ} 40' N.$  sails between the S. and E. 600 miles, and then her departure is computed to be 308 miles; required the course, latitude, and difference of longitude?

*Ans.* { Course S.  $30^{\circ} 53' E.$  latitude in  $37^{\circ} 5' N.$  difference of longitude 411.5, by Mercator.  
 Course S.  $30^{\circ} 53' E.$  latitude in  $37^{\circ} 5' N.$  difference of longitude 410.4, by Middle Latitude.

*Quest. 6.* A ship from the latitude  $45^{\circ} 30' S.$  sails N. N. W. until her difference of longitude be  $7^{\circ} 40'$ ; required the latitude she is in, and her distance sailed?

NOTE. This must be worked by Mercator's Sailing, thus:

As tang. course  $22^{\circ} 30'$  : radius or  $90^{\circ}$  :: the difference of longitude : to the mer. diff. of latitude 1110 miles. Now, from the meridian parts of latitude left 3073, take the meridian diff. of latitude 1110, the remainder 1963, is the meridian parts of the latitude come to  $31^{\circ} 4' S.$  Having the course and proper difference of latitude, the rest is found by Case II. in Plane Sailing.

*Ans.* The ship is in latitude  $31^{\circ} 4' S.$  distance 937.4 miles.

*Quest. 7.* A ship in the latitude  $51^{\circ} 15' N.$  and longitude  $22^{\circ} W.$  sails between the S. and W. until she has made 564 miles of departure, and 786 miles of difference of longitude; required her course, distance, and latitude, and longitude in?

NOTE. This must be worked by Middle Latitude Sailing, thus:

As diff. of long. 786 : radius :: the departure 564 : co-sine of middle latitude  $44^{\circ} 9' + 44^{\circ} 9' = 88^{\circ} 18'$  the sum lat. and  $88^{\circ} 18' - 51^{\circ} 15' =$  lat. left  $37^{\circ} 3' N.$  Having the difference of latitude and departure, the course is found to be S.  $30^{\circ} 30' W.$  and the distance 1021.7 miles.

It may now be supposed that the Learner is capable of working any single course, either by Middle Latitude or Mercator's Sailing; we shall now proceed to Compound Courses, commonly called Traverse Sailing, which may be worked by Middle Latitude and Mercator's Sailing; either by projection, calculation, Gunter's scale, or inspection.

How to solve compound courses, or a traverse, has already been shewn in Plane Sailing; but it is necessary also to show, how proper allowances for the longitude should be introduced into such accounts, which is easily done by any of the following methods;

1st. Complete the traverse table to each course and distance as in Plane Sailing, and find the whole difference of latitude, departure and latitude in.

2dly. With the whole difference of latitude and departure, find the direct course and distance.

3dly. With the latitude left and latitude in, find the complement of the middle latitude; with which and the departure, find the difference of longitude by Middle Latitude Sailing.

Or, with the course and meridional difference of latitude, find the difference of longitude by Mercator's Sailing.

These methods are generally used in working a day's-work at sea; but those that want a greater degree of accuracy, may work by the following methods, especially in high latitudes:

By the several differences of latitudes and departures, found in the tables of difference of latitude and departure, find the latitudes come to, middle latitudes, and complements of middle latitudes: with each complement of middle latitude and corresponding departure, find the difference of longitude to each course and distance; and set them down in the two additional columns marked difference of longitude, east and west, according to the departure used; add up the east and west columns, and their difference will be the whole difference of longitude, by Middle Latitude Sailing.

But if you work by Mercator's Sailing, find the meridional difference of latitude for each course and distance; with each course and meridional difference of latitude, find the difference of longitude; which set down as above directed, and the difference between the east and west columns will be the difference of longitude by Mercator's Sailing. By this method the ship's place may be found at the end of each course and distance run, and pricked off on a Mercator's chart.

### EXAMPLE I.

Suppose a ship from the Land's End in latitude  $50^{\circ} 6' N.$  and longitude  $5^{\circ} 55' W.$  is bound to the island of St. Mary's in latitude  $37^{\circ} N.$  and longitude  $25^{\circ} 6' W.$  but by reason of contrary winds is obliged to steer the following courses, viz. S. by W. 24 miles, W. S. W. 32, N. W.  $\frac{1}{2} W.$  41, S. S. E.  $\frac{1}{4} E.$  49, E. N. E.  $\frac{1}{4} E.$  19, W. 21, N. E.  $\frac{1}{2} E.$  36, S. 41, S. S. W. 92, and N. 36 miles; and it be required the latitude and longitude she is in, with the direct course and distance to her intended port?

With the several courses and distances, find their differences of latitude and departure, and set them down as in the following Traverse Table:

P

TRAVERSE

## TRAVERSE TABLE.

| Courses.                  | Dist. | Diff. of Lat. |       | Departure. |       |
|---------------------------|-------|---------------|-------|------------|-------|
|                           |       | N.            | S.    | E.         | W.    |
| S. by W.                  | 24    |               | 23,5  |            | 4,7   |
| W. S. W.                  | 32    |               | 12,2  |            | 29,6  |
| N. W. $\frac{1}{2}$ W.    | 41    | 26,0          |       |            | 31,7  |
| S. S. E. $\frac{1}{4}$ E. | 49    |               | 44,3  | 21,0       |       |
| E. N. E. $\frac{1}{4}$ E. | 19    | 4,6           |       | 18,4       |       |
| West.                     | 21    |               |       |            | 21,0  |
| N. E. $\frac{1}{2}$ E.    | 36    | 22,8          |       | 27,8       |       |
| South.                    | 41    |               | 41,0  |            |       |
| S. S. W.                  | 92    | 36,0          | 85,0  |            | 35,2  |
| North.                    | 36    |               |       |            |       |
|                           |       | 89,4          | 206,0 | 67,2       | 122,2 |
|                           |       |               | 89,4  |            | 67,2  |
|                           |       | Diff. lat. S. | 116,6 | Depar.     | 55,0  |

It is plain by the Traverse Table, that the ship has made 116,6 miles of southing, and 55 miles of westing.

Now from latitude left  $50^{\circ} 6'$  Meridian parts 3484  
Take diff. of lat. 117 = 1 57

Latitude in  $48^{\circ} 9' N.$  Meridian parts 3305

Sum latitudes 2)98 15

Middle latitude  $49^{\circ} 7'$  Meridian difference 179

Whence to find the Difference of Longitude it will be,

By Middle Latitude Sailing.

By Mercator's Sailing.

As co-sine mid. lat.  $49^{\circ} 7'$  9.81592  
Is to the departure 55 1.74036  
So is radius  $90^{\circ}$  10.00000

11.74036  
9.81592

To diff. long.  $84 = 1^{\circ} 24'$  1.92444  
Long. left 5 55

Long. in  $7^{\circ} 19'$  by m. lat.

As p. diff. of lat. 116,6 2.06679  
Is to the departure 55 1.74036  
So is mer. diff. lat. 179 2.25285

3.99311  
2.06679

To diff. lon.  $84,4 = 1^{\circ} 24'$  1.92651  
Long. left 5 55

Long. in  $7^{\circ} 19'$  by Mer.

By



By INSPECTION.

Taking the complement of middle latitude  $41^{\circ}$  as a course, and the departure 55 in its column, the nearest is 55,1, against which stands 84 in the distance column, the difference of longitude by Middle Latitude Sailing. And,

With the proper difference of latitude and departure, the course found nearly  $25^{\circ}$  and distance 129 under the course; in the latitude column look for the meridian difference of latitude 179, the nearest is 180,4, against which stands 84,1 in the departure column, which is the difference of longitude by Mercator's Sailing.

To find the direct Course and Distance to St. Mary's.

Lat. of ship  $48^{\circ} 9' N.$  Merid. pts. 3305 Lon. of ship  $7^{\circ} 19' W.$   
 Lat. St. Mary's  $37^{\circ} N.$  Merid. pts. 2393 L. St. Mary's  $25^{\circ} 6' W.$

Diff.  $11^{\circ} 9' = 669$  ms. Diff.  $9^{\circ} 12' = 576$  Diff of Long.  $17^{\circ} 47' = 1067$

Sum lat.  $2)85^{\circ} 9'$

Mid. lat.  $42^{\circ} 34'$

By Middle Latitude Sailing.

|                                         |          |                                   |          |
|-----------------------------------------|----------|-----------------------------------|----------|
| As the diff. of lat. 669                | 2.82543  | As co-fi. course $49^{\circ} 35'$ | 9.81180  |
| Is to diff. of long. 1067               | 3.02816  | Is to prop. diff. of lat. 669     | 2.82543  |
| So is co-fi. mid. lat. $42^{\circ} 34'$ | 9.86717  | So is radius $90^{\circ}$         | 10.00000 |
|                                         | 12.89533 |                                   | 12.82543 |
|                                         | 2.82543  |                                   | 9.81180  |

To tang. course  $49^{\circ} 35'$  10.06990 To the dist. 1032 3.01363

By Mercator's Sailing.

|                                         |          |                                      |          |
|-----------------------------------------|----------|--------------------------------------|----------|
| As merid. diff. of lat. $9^{\circ} 12'$ | 2.95999  | As radius                            | 10.00000 |
| Is to radius $90^{\circ}$               | 10.00000 | Is to p. diff. of lat. 669           | 2.82543  |
| So is diff. of long. 1067               | 3.02816  | So is secant course $49^{\circ} 29'$ | 10.18731 |
|                                         | 13.02816 |                                      | 13.01274 |
|                                         | 2.95999  |                                      | 10.00000 |

To tang. course  $49^{\circ} 29'$  10.06817 To the distance 1030 3.01274

Hence the direct course from the ship to St. Mary's is S.  $49^{\circ} 35'$  W. and distance 1032 miles, by Middle Latitude Sailing; and S.  $49^{\circ} 29'$  W. and distance 1030 miles, by Mercator's Sailing. The same may be found

By INSPECTION.

Take  $\frac{1}{4}$  of the diff. of 1067, viz. 267 nearly, and look for that in the dist. column over the complement middle  $47^{\circ}$  nearly, and in the departure column stands  $195,3\frac{1}{4}$  of the departure.

Then look for  $\frac{1}{2}$  167,2, and  $\frac{1}{2}$  of departure 195,3, until they are found standing together in their respective columns, the nearest are found over  $49^{\circ}$  and  $50^{\circ}$ , viz. 195,5, 169,9, and 195,3, 163,9; the distances corresponding to these are 259 and 255, their sum is 514, half is 257, this multiplied by 4, gives 1028 miles. Hence the course is S.  $49^{\circ} 40'$  W. dist. 1028 miles, by Mid. Lat. Sailing.

Again, taking  $\frac{1}{16}$  of the meridional difference, and  $\frac{1}{16}$  of the diff. of longitude, viz. 91,2 and 106,7, the nearest numbers to these are 106,4, 92,5, and 106,5; 89,4 standing over  $49^{\circ}$  and  $50^{\circ}$  in the latitude columns, belonging to the above degrees; look for  $\frac{1}{16}$  of the proper difference of latitude, viz. 66,9, the nearest is 66,9 and 66,8, the distances to these are 102 and 104, their sum is 206, half is 103, which being multiplied by 10, gives 1030 miles.

Hence the course is S.  $49^{\circ} 30'$  W. and distance 1030 miles, by Mercator's Sailing, the same as by calculation.

Here to have gone to geometrical strictness, the difference of longitude should have been found to every course and distance run, by Middle Latitude or Mercator's Sailing, which would have given the ship's true place at the end of each course and distance, but shall leave the doing of that to the Reader; and as all traverses are worked in the manner shown above, which is sufficiently exact for a ship's run in 24 hours, I shall therefore only add a few questions for the Learner's exercise.

Suppose a ship from the latitude  $68^{\circ} 38'$  N. and longitude  $8^{\circ} 40'$  E. is bound to the North Cape, in  $71^{\circ} 10'$  N. and longitude  $26^{\circ} 3'$  E. sails as in the following table; required the latitude and longitude she is in, and her direct course and distance to the Cape.

| Courses.                    | D. | N.    | S.   | E.    | W.   | Lat. in    | Diff. of Long.<br>E. W. |
|-----------------------------|----|-------|------|-------|------|------------|-------------------------|
| N. E. by N.                 | 63 | 52,4  |      | 35,0  |      | 68 38      |                         |
| N. E.                       | 38 | 26,9  |      | 26,9  |      | 69 30      | 97,2                    |
| N. N. E.                    | 56 | 51,7  |      | 21,4  |      | 69 57      | 78,0                    |
| North.                      | 30 | 30,0  |      |       |      | 70 49      | 64,2                    |
| N.W. by N.                  | 25 | 20,8  |      |       | 13,9 | 71 19      |                         |
| N.N.W. $\frac{1}{2}$ W.     | 36 | 31,7  |      |       | 17,0 | 71 40      | 44,1                    |
| N. by E.                    | 40 | 39,2  |      | 7,8   |      | 72 12      | 55,0                    |
| N.E. by E. $\frac{1}{2}$ E. | 72 | 33,9  |      | 63,5  |      | 72 51      | 26,0                    |
| S. E.                       | 50 |       | 35,3 | 35,3  |      | 73 25      | 219,4                   |
| E. N. E.                    | 65 | 24,9  |      | 60,0  |      | 72 50      | 120,6                   |
|                             |    |       |      |       |      | 73 15      | 207,9                   |
|                             |    | 311,5 | 35,3 | 249,9 | 30,9 |            | 813,3                   |
|                             |    | 35,3  |      | 30,9  |      |            | 99,1                    |
| Diff. of lat.               |    | 276,2 | Dep. | 219,0 |      | Diff. lon. | 714,2 E.                |

In working the above, the difference of longitude is found by the course and meridional difference between each parallel of latitude; or, it may be done by taking the complements of each middle latitude, and the departure for each course.

Now the lat. left, was  $68^{\circ} 38' N.$  Long.  $8^{\circ} 40' E.$   
 The diff. of lat. 276 ms. = 4 36 N. Diff. of lon. 714 m. = 11 54 E.

|                 |   |       |               |          |
|-----------------|---|-------|---------------|----------|
| Lat. in         | — | 73 14 | Long. in      | 20 34 E. |
| Lat. of N. Cape |   | 71 10 | Long. of Cape | 26 3 E.  |

The m. dif. lat. is 406 ms.  $2 \ 4 = 124$  ms. Dif. of long.  $5 \ 29 = 329$  miles.

With the meridional difference of latitude 406, and difference of longitude 329, the course between the ship and the Cape is S.  $39^{\circ} 1'$  E. distance 160 miles, by Mercator; and S.  $39^{\circ} 3'$  E. distance 159,7, by Mid. Lat. Sailing.

### By I N S P E C T I O N.

With  $\frac{1}{3}$  of diff. of lat. 276, and  $\frac{1}{3}$  of departure 219, viz. 92 and 73, the course made good is  $38^{\circ} 30'$ , and distance 354 miles.

And with  $\frac{1}{10}$  of meridional difference of latitude 849, and the course  $38^{\circ} 30'$ , the difference of longitude is 676, by Mercator's Sailing.

And, with the complement of middle latitude 19,2 and the departure 219, the difference of longitude is 675 nearly, by Middle Latitude Sailing; differing from that above 38 miles by Mercator, and 39 miles by Middle Latitude Sailing.

But as ships never run such distances in 24 hours, the first method of finding the difference of longitude will be sufficiently exact for any day's run.

The bearing and distance to the North Cape may be either found by Middle Latitude or Mercator, by inspection, which will be nearly as above.

A ship from the Lizard in latitude  $49^{\circ} 57' N.$  and longitude  $5^{\circ} 14' W.$  is bound to Funchal in Madeira, in latitude  $32^{\circ} 38' N.$  and longitude  $17^{\circ} 5' W.$  steers the following courses, S. S. W. 250 miles, W. 156, S. E. by S. 300, W. by N. 180, and S. 185 miles; required the latitude and longitude she is in, and her direct course and distance to the intended port?

By finding the difference of longitude for each course by calculation, the ship is in latitude  $39^{\circ} 27' N.$  and longitude  $11^{\circ} 28' W.$  by Mercator's Sailing; but by working by the whole difference of latitude and departure, the longitude will be  $11^{\circ} 23' W.$

The course from the ship to Funchal, is S.  $33^{\circ} 15' W.$  distance 489 miles, by Mercator's Sailing.

And S.  $33^{\circ} 19' W.$  distance 489,4 miles, by Middle Latitude Sailing.

A ship



A ship from latitude  $38^{\circ} 14' N.$  and longitude  $25^{\circ} 56' W.$  runs the following courses and distances, viz. N. E. by N.  $\frac{1}{2}$  E. 40 miles, N. N. W. 38, N. W. by W. 46, S. S. E. 30, S. by W. 20, and N. E. by N. 60 miles; required the direct course and distance made good, and the latitude and longitude she is in?

The course is N. by E. distance 111 miles, latitude in  $49^{\circ} 2' N.$  longitude in  $25^{\circ} 28' W.$

Suppose a ship in latitude  $67^{\circ} 30'$  and longitude  $8^{\circ} 46' W.$  sails the following courses, N. E. 64 miles, N. N. E. 50, N. W. by N. 58, W. N. W. 72, W. 48, S. S. W. 38, S. by E. 45, and E. S. E. 40 miles; what latitude and longitude is she in?

By working by the whole difference of latitude and departure, the ship is in latitude  $68^{\circ} 43' N.$  and longitude  $11^{\circ} 3' W.$  But,

By finding the difference of longitude for each course and distance, she is in longitude  $11^{\circ} 37' W.$  by Middle Latitude Sailing, and  $11^{\circ} 43' W.$  by Mercator's Sailing.

Having gone through the necessary problems in Mercator's Sailing, we shall now proceed to shew how the true chart, commonly called Mercator's Chart, may be constructed either for the whole, or any part of the Terraqueous Globe.

*When a Chart is to commence from the Equator, or if the Equator is to run through it.*

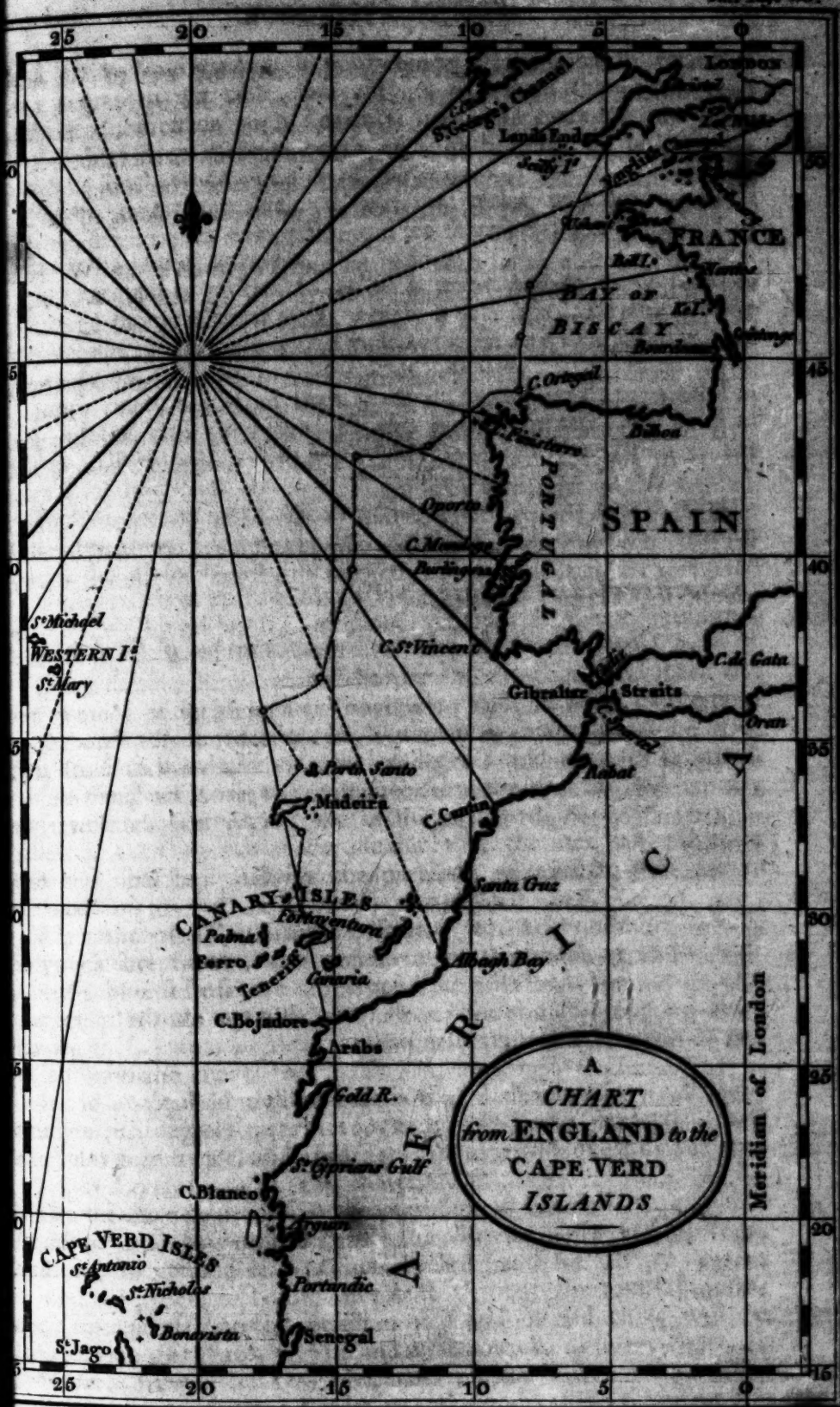
Having provided a scale of convenient length, draw a line to represent the equator, and crossing that at right angles, another to represent the meridian of some known place, such as London, Paris, the Lizard, or any other place whose longitude is known; the upper end of which will represent the north, and the lower the south.

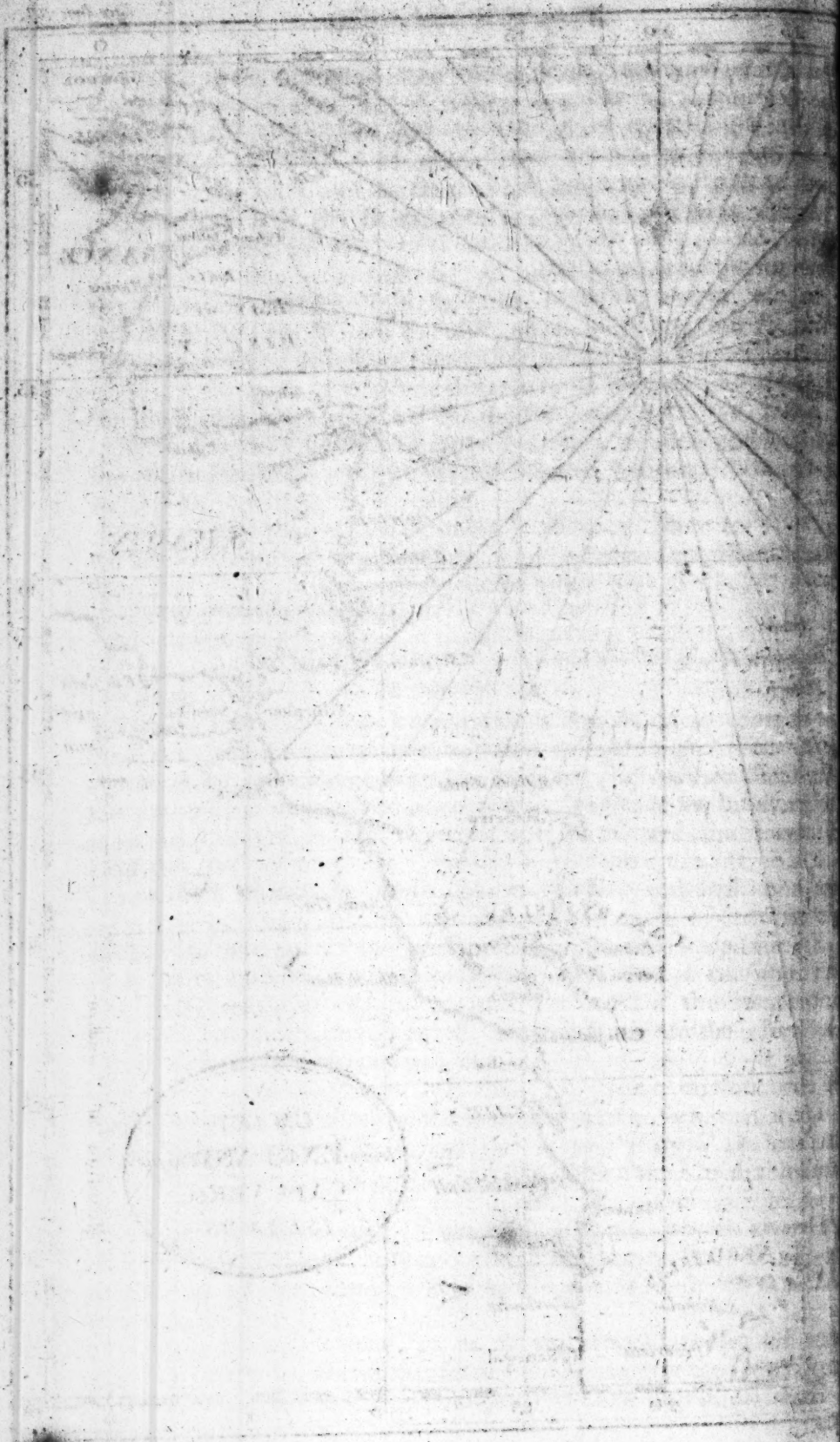
From the scale take 60 in your compasses, and with one foot upon the meridian, set off that distance on both of it upon the equator, if the chart is to contain east and west longitude; but, if it is only to contain east or west longitude, lay it off upon that side of the meridian the case requires: that is, if the longitude is to be westward, lay it off on the left-hand side of the meridian; but if easterly, the right-hand side.

Again, take 2 degrees or 120 miles in your compasses, and set it off from the meridian, in the same manner as before; or, with 60 miles in the compasses, turn over from the meridian, and that will point out the degrees of longitude, which may be divided into halves, quarters, or minutes, if required.

Having set off as many degrees of longitude as you intend the chart should contain, through the last draw a line, (or lines) parallel to the meridian, which will be the bounds of the chart east and west.

Having divided the equator as above, proceed to set off upon the two extreme meridians from the equator, the meridional parts (as found in the table) belonging to each degree of latitude; that





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that is, take from the scale in your compasses, the miles answering to one degree in the table, and with one foot in the equator, set off that distance on each side of it upon the extreme meridians, if the chart is to contain north and south latitude; but if only north or south, upon one side of the equator.

Again, take the meridional parts answering to 2 degrees and 3 degrees, &c. in your compasses, and set them off upon the meridian from the equator, as before.

In like manner proceed to set off as many degrees as you intend the chart should contain; or, which will be the same thing, take the meridional difference of latitude between any two parallels, and set them off severally from the least latitude.

Lay a ruler on each of these divisions, and draw lines parallel to the equator, and they will be the parallel of latitude; each of which will be enlarged towards the poles, in proportion as the degrees of longitude are.

Parallel to the meridian, draw lines through the points, expressing the degrees of longitude, to cut the parallels of latitude, which bound the chart north and south.

The parallels of latitude may also be divided into halves, quarters, or minutes, by taking the meridional parts for degrees and minutes, and setting them off as before.

Draw double lines on the borders of the chart, and mark out the degrees of latitude and longitude; and, in some convenient place, draw the compass. In like manner may a chart be made that shall contain any number of degrees and minutes required. When the chart is not to commence from the equator, but is only to serve from a certain distance on the meridian, between two parallels on the same side of the equator, then the meridians are to be drawn as before; and for the parallels of latitude you are to proceed thus:

From the meridional parts answering to each point of latitude in your chart, subtract the meridional parts answering to the least latitude, and set off the difference severally from the parallels of the least latitude upon the two extreme meridians, and the lines joining these points of the meridian will represent the several parallels upon the chart.

Let it be required to draw a chart that shall serve from the latitude of 14 degrees north, to 52 degrees north, and that shall contain 1 degree east, and 26 degrees of longitude west of the meridian of London.—See the chart.

Draw a line to represent the meridian of London, from which set off 60 miles toward the right hand, for one degree of longitude, and on the other side towards the left hand set off 26 degrees of west longitude, as before directed: through the two last points draw lines parallel to the meridian of London, and these will be the extreme meridians, or east and west bounds, of your chart.

Having drawn the two meridians on the lower edge of the paper, draw a line perpendicular to the meridians, to represent the parallel

parallel of 14 degrees north; then, from the meridional part answering to 15 degrees 910, subtract the meridional part answering to 14 degrees 848, and take the difference 62 in your compasses, and set it off from the parallel on both the meridians from you, and that will represent the parallel of 15 degrees.

Again, take the meridional parts of 15 degrees 910, from the meridional parts of 16 degrees 973, and set off the difference 63 upon the meridians from the point representing the parallel of 15 degrees, and that will represent the parallel of 16 degrees. In like manner proceed to set off the parallels upon the meridians.

Or, if the meridional parts of 14 degrees be subtracted from the meridional parts of every succeeding parallel, and the difference be set off from the parallel of 14 degrees upon the meridians, these points will represent the several enlarged parallels of latitude, the same as before; and, if it be required that the meridians should be divided into degrees and meridians, the meridional parts for such must be taken from the table, and set off as above.

Having set off as many parallels as you intend the chart should contain, through each point draw parallels, or if you think drawing lines through every degree will crowd your chart too much, you may divide the borders only into single degrees, &c. and draw lines through every 5 degrees of latitude and longitude, as in the chart.

Take from the table of latitude and longitude of places, the latitude and longitude of each particular place contained within the bounds of the chart, and lay a ruler over its latitude, and another crossing that over its longitude; the point where these cross will represent the proposed place upon the chart. In like manner may any plate be readily marked. Hence, the particular points of a sea-coast may be laid down as above, and lines properly drawn from point to point, will form the out-lines of the sea coasts, islands, &c. to which may be annexed, the depths of water, setting of currents, and whatever else may be thought convenient for the chart to contain.

This map or chart is not to be considered as a just or similar representation of the earth's surface, for in it the figures of islands and countries are distorted near the poles. For,

Suppose an island in the latitude  $60^{\circ}$  N. or S. where the breadth of a degree of longitude is just half as large as a degree upon the equator. Now as the degrees of latitude are enlarged in proportion as the degrees of longitude are expanded towards the poles, it is plain, that every point of that island or country, being laid down in its proper latitude and longitude, will be represented twice as large as it really is.

Hence it follows, that as the degrees of latitude are every where increased like those of longitude, it is plain the bearings between places will be the same on this chart as on the globe; and the proportions between the latitude and longitude and nautical distances, will be the same upon this chart as upon the globe.

And

And since the meridians in this projection are right-lines, it follows, that the rhumbs which form equal angles with the meridians will be straight lines, which render this projection of the earth's surface much more easy and proper for the mariner's use than any other.

Gunter's Scales have drawn upon them 2 lines, one marked M signifying the Nautical Meridian; and the other directly under it marked E P, signifying Equal Parts, or degrees of longitude, upon a Mercator's Chart.

Those are equal parts, or degrees of longitude, to which the degrees of the nautical meridian are fitted, by increasing them in their true proportion; hence the limits or bounds of a Mercator's chart by these lines are easily made, by transferring the divisions corresponding to the degrees to be used, from the scale to the paper the chart is to be drawn upon: but as the degrees drawn by these lines are too small for the seaman's use, it is much better to use a scale of equal parts as before, and consequently the degrees may be made of any proposed length.

*By the Latitude and Longitude in, to prick off the Ship on the Chart.*

RULE. Lay the ruler across the chart in the latitude your ship is in, then look upon the equator, or line marked with the degrees of longitude, for the longitude your ship is in by your reckoning, and setting one foot of your compasses in that longitude, take the nearest distance to some north and south line, and from where that line crosses the edge of the ruler that lies in the given latitude; set off that same distance along the edge of the ruler to the right hand, if the longitude you are in was to the right hand of the north and south line, or to the left hand, if it was to the left hand; where this falls will be the place of the ship: but this will only do when the longitude marked on the chart, and your reckoning of longitude in, are both counted from the same meridian. Therefore, for a general rule, take the following, viz.

*By the Latitude in and Longitude made, to prick off the Ship's Place.*

RULE. Set one foot of your compasses in the place you take your departure from, and take the nearest distance to some north and south line, and from where that line falls upon the equator, or the line marked with the degrees of longitude, set off that distance the same way the place lies from it; that is, to the right hand, if the place lies to the right hand of the north and south line, or to the left hand, if it lies to the west; and make a mark with a black lead pencil; this mark will serve to prick off by, till you come to take a new departure; and then rub it out, and make a new one as before.

Then lay a ruler across the chart in the latitude you are in, and setting so many degrees in your compasses from the line of longitude, as your longitude made comes to, set them off from your black lead mark along the edge of the ruler to the eastward; if the

longitude

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longitude made be east, or the westward if it be west; where this falls will be the longitude the ship is in by the chart; from which take the nearest distance to some north and south line, and from where that line, &c. as in the first case.

The ship's place on the chart being found, as before taught, remains in the next to shew how to find the bearing and distance of any place from the ship; and first,

*To find how any Place bears from the Ship.*

**RULE.** Lay a ruler from the place of the ship to the place you would know the bearing of; then set one foot of your compasses in the centre of some compass near the ruler, and take the nearest distance to the edge of the ruler; then run one foot of your compasses along by the edge of the ruler, and observing what point of the compass the other comes nearest to, which will be the bearing required.

*To find the Distance of any Place from the Ship.*

**C A S E I.**

If the place be in the same longitude that the ship is in; that is, if it bears due north or south, then the difference of latitude between them turned into miles or leagues, will be the distance.

**C A S E II.**

If the place be in the same latitude the ship is in; that is, if it bears due east or due west, then take half the distance between the ship and the place in your compasses; and setting one foot on the line marked with the degrees of latitude, in the latitude the ship is in, see what latitudes the other foot will reach to, both above and below it; the difference between these two latitudes will be the distance required.

**C A S E III.**

*When they are neither in the same Latitude nor in the same Longitude with the Ship.*

**RULE.** Take the difference of latitude between both places in your compasses from the equator, or graduated parallel; and laying a ruler over both places, put one foot on the ship's place, and slide your compasses along the edge of the ruler (holding both points parallel to the meridian) until the other cuts the parallel of latitude passing through the place, (or E. and W. line cut by the ruler) and then stay the compasses. Take the distance between where the point rested by the edge of the ruler and the place (or where the ruler crossed the aforesaid east and west line) in your compasses, and apply it to the equator, or graduated parallel, and that will give their distance in degrees, which may be turned into miles or leagues; and in the same manner as you find the bearing and distance

tance between the ship and any place, you may also find the bearing and distance of one place from another; or if the distance between the ship and place be taken in your compasses, and applied to the side of the chart, or graduated meridian, nearly in the parallels of the ship and place, will give the distance in degrees as before; and for this purpose there are generally marked on the sides of charts scales of leagues, by which the distance between the places may be readily found.

Or the distance between two places upon a Mercator's chart may be easily found, thus:

Take half the distance between any two places, and with one foot of the compasses in the middle parallel, extend both ways upon the graduated meridian; count the number of degrees between both points which will be your distance, either in leagues or miles according as the scale is divided; or take the distance in your compasses, and set one foot as much above the one place as the other point is below the other place, on the meridian, the number of degrees between the points of the compasses will be the distance.

### EXAMPLE.

*Required the Bearing and Distance between Cape St. Vincent and Teneriff?*

Lay a ruler over both places, and take their difference of latitude  $8^{\circ} 30'$ , from the equator or graduated parallel, in your compasses; and slide one foot along the edge of the ruler from Teneriff, holding the other point in the direction of the line CB, until the other point just touches the east and west line, (AB) passing through St. Vincent, as at B, from C where the foot of the compasses rested, by the edge of the ruler, and St. Vincent being measured, and applied to the graduated parallel, gives 10  $\frac{2}{3}$  degrees, or 640 miles the distance.

Again, take the nearest distance between the centre of the compass in your compasses, and sliding them along the edge of the ruler as before directed, you will find the course to be S. W. by S.  $\frac{1}{4}$  W. nearly.

Hence the direct course between Cape St. Vincent and Teneriff is S. W. by S.  $\frac{1}{4}$  W. distance 640 miles, or 213  $\frac{1}{3}$  leagues; and the same with other places.

## OF WINDS.

**T**HE earth is endued with a wonderful principle of gravitation, whereby all its parts are strictly united together; and all bodies that are loose upon it, closely adhere to its surface, tending directly towards its centre. Hence it is, that ships are able to sail with the same facility every where (void of impediments) upon the surface of the sea, quite round the terraqueous globe; and that is (as to sense) there is no such thing as an upper or lower part of the earth; for let the inhabitant be in what part soever, he will there graviate towards the earth's centre, and imagine himself to be on the highest point of its surface; from whence he will observe the heavens like a large vault over his head, and his antipodes he will imagine to be directly under him, as they will also theirs, for the like reason. According to this law of gravity, if the earth were at rest (and not acted upon by any other power) and its parts loose, or its surface all over covered with a deep fluid; it would naturally form itself into a true sphere or globe.

Notwithstanding this power of attraction, yet the sun, whose rays upon the earth cause vapours or fumes to be continually rising from it, which must partake of the quality of those parts, from whence they are evaporated; a collection of which form what we call our air or atmosphere, surrounding the earth, and extending some miles above its surface, and is liable to be put in motion by various causes. Hence, air is a fine elastic fluid, and is found capable of being compressed, or condensed by cold, and expanded or rarefied by heat.

Consequently, an alteration of heat or cold happening in any part of the atmosphere, the air in that part will be either condensed or rarefied, and the neighbouring parts will thereby be put into motion, through the endeavour which the air by its elasticity or springiness always makes to restore itself to its former state, or come to an equilibrium.

Wind is a stream or current of air, which generally blows from one part of the horizon to its opposite.

The following observations have been made on it, particularly by Dr. Halley, which are not unworthy the seaman's notice:

Between 30 degrees north latitude, and 30 south latitude, there is a constant east wind throughout the year, blowing on the



the Atlantic and Pacific oceans, and this is called the Trade Winds.

For as the sun, in moving from east to west, heats the air more immediately under him, and thereby expands it; the air to the eastward is constantly rushing towards the west to restore the equilibrium or natural state of the atmosphere, which occasions a perpetual east wind in those limits.

The trade winds, near these northern limits, blow between the north and east; and, near the southern limits, they blow between the south and east.

For as the air is expanded by the heat of the sun near the equator, therefore the air from the northward and southward will both tend toward the equator to restore the equilibrium: now these motions from the north and south, joined with the foregoing easterly motion, will produce the motions observed near those limits, between the north and east, and between the south and west.

These winds, if the whole surface of the globe were sea, would undoubtedly blow quite round it, as they are found to do in the Atlantic and Ethiopic oceans; but seeing such great continents interpose and break the continuity of the ocean, regard must be had to the nature of soils, and the position of high mountains, which are the principal causes of the variety of winds differing from the former general one.

In some parts of the Indian ocean there are periodical winds, which are called Monsoons; that is, such as blow half the year one way, and the other half year the contrary way.

For air that is cool and dense will force the warm and rarefied air into a continual stream upwards, where it must spread itself to preserve the equilibrium; so that the upper course or current of the air shall be contrary to the under current; for the upper air must move from those parts where the greatest heat is, and so by a kind of circulation the N. E. trade wind below will be attended with a S. W. above, and a S. E. below with a N. W. above: And this is confirmed by the experience of seamen, who, as soon as they get out of the trade winds, immediately find a wind blowing from the opposite quarter.

In the Atlantic ocean, near the coasts of Africa, at about 100 leagues from shore between the latitudes of  $28^{\circ}$  and  $10^{\circ}$  north, seamen constantly meet with a fresh gale of wind blowing from the N. E.

Those bound to the Caribbee Islands across the Atlantic, find, as they approach the American side, that the said N. E. wind becomes easterly, or seldom blows more than a point from the east either to the northward or southward.

These trade winds on the American side are extended to  $30^{\circ}$ ,  $31^{\circ}$ , or even to  $32^{\circ}$  of north latitude; which is about  $4^{\circ}$  farther than what they extend to on the African side; also to the southward

ward of the equator, the trade winds extend 3 or 4 degrees farther towards the coast of Brazil on the American side, than they do near the cape of Good Hope on the African side.

Between the latitudes of 4 degrees north, and 4 south, the wind always blows between the south and east: On the African side the winds are nearest the south, and on the American side nearest the east. In these seas Dr. Halley observed, that when the wind was eastward, the weather was gloomy, dark, and rainy, with hard gales of wind; but when the wind veered to the southward, the weather generally became serene, with gentle breezes next to a calm.

These winds are somewhat changed by the seasons of the year; for when the sun is far northward, the Brazil S. E. wind gets to the south, and the N. E. wind to the east; and when the sun is far south, the S. E. wind gets to the east, and the N. E. wind on this side of the equator veers more to the north.

Along the coast of Guinea, from Sierra Leon to the island of St. Thomas under the equator, which is above 500 leagues, the southerly and S. W. winds blow perpetually; for the S. E. trade wind having passed the equator, and approaching the Guinea coast, within 80 or 100 leagues, inclines towards the shore, and becomes S. S. E. then south, and by degrees, as it comes near the land, it veers about to S. S. W. and within the land it is S. W. and sometimes W. S. W. This track is troubled with frequent calms, and violent sudden gusts of wind, called Tornadoes, blowing from all points of the horizon.

The reason of the wind setting in west on the coast of Guinea, is, in all probability, owing to the nature of the coast, which being greatly heated by the sun, rarefies the air exceedingly, and consequently the cool air, from off the sea, will keep rushing in to restore the equilibrium.

Between the 4th and 10th degrees of north latitude, and between the longitude of Cape Verd and the easternmost of the Cape Verd islands there is a track of sea which seems to be condemned to perpetual calms, attended with terrible thunder and lightnings, and such frequent rains, that this part of the sea is called The Rains. Ships in sailing these 6 degrees have been sometimes detained whole months, as it is reported.

The cause of this seems to be, that the westerly winds setting in on this coast, and meeting the general easterly winds in this track, balance each other, and so cause the calms and the vapours; carried thither by each wind, meeting and condensing, occasion the almost constant rains.

The last three observations shew the reason of the two following, which mariners experience in sailing from Europe to India, and in the Guinea trade. The difficulty which ships in going to the southward, especially in the months of July and August, find in passing

passing between the coasts of Guinea and Brazil, notwithstanding the width of this sea is more than 500 leagues: This happens because the S. E. winds at that time of the year commonly extend some degrees beyond the ordinary limits of  $4^{\circ}$  N. latitude; and besides, coming so much southerly, as to be sometimes south, sometimes a point or two to the west; it then only remains to ply to windward. And if on the one side they steer W. S. W. they get a wind more and more easterly; but then there is danger of falling in with the Brazilian coast, or shoals; and if they steer E. S. E. they fall into the neighbourhood of the coast of Guinea, from whence they cannot depart without running easterly as far as the island of St. Thomas, and this is the constant practice of all the Guinea ships.

All ships departing from Guinea for Europe, their direct course is northward; but on this course they cannot go, because the coast bending nearly east and west, the land is to the northward; therefore as the winds on this coast are generally between the S. and W. S. W. they are obliged to steer S. S. E. or S. and with these courses they run off the shore; but in so doing they always find the wind more and more contrary, so that when near the shore they can lie south; at a great distance they can make no better than S. E. and afterwards E. S. E. with which courses they generally fetch the island of St. Thomas, and Cape Lopez, where finding the winds to the eastward of the south, they sail westerly with it, till coming to the latitude of four degrees south, where they find the S. E. wind blowing perpetually.

On account of these general winds all those that use the West India trade, even those bound to Virginia, reckon it their best course to get as soon as they can to the southward, that so they may be certain of a fair and fresh gale to run before it to the westward; and for the same reason those homeward bound from America endeavour to gain the latitude of  $30^{\circ}$ , where they first find the wind begin to be variable, though the most ordinary winds in the North Atlantic ocean come between the south and west.

Between the southern lats. of 10 and  $30^{\circ}$  in the Indian ocean, the general trade wind about S. E. by S. is found to blow all the year round in the same manner as in the like lats. in the Ethiopic ocean, and during the six months, from May to December, these winds reach to within  $2^{\circ}$  of the equator; but during the other six months, from November to June, a N. W. wind blows in the track lying between the 3d and 10th degrees of southern lat. in the meridian of the north end of Madagascar; and between the 2d and 12th degrees of south lat. near the long. of Sumatra and Java.

In the track between Sumatra and the African coast, and from  $3^{\circ}$  of S. lat. quite northward to the Asiatic coasts, including the Arabian sea and the gulf of Bengal, the monsoons blow from September to April on the N. E. and from March to October on the S. W.



S. W. In the former half year, the wind is more steady and gentle, and the weather clearer than in the latter six months: and the wind is more strong and steady in the Arabian sea than in the gulf of Bengal.

Between the island of Madagascar and the coast of Africa, and thence northward as far as the equator, there is a track wherein, from April to October, there is a constant fresh S. S. W. wind, which, to the northward, changes into the W. S. W. wind blowing at that time in the Arabian sea.

To the eastward of Sumatra and Malacca, on the north of the equator, and along the coasts of Cambodia and China quite through the Philippines as far as Japan, the monsoons blow northerly and southerly; the northern setting in about October or November, and the southern about May. These winds are not quite so certain as those in the Arabian sea.

Between Sumatra and Java to the west, and New Guinea to the east, the same northerly and southerly winds are observed; but the first half year the monsoons incline to the N. W. and the latter to the S. E. These winds begin a month or six weeks after those in the Chinese seas set in, and are quite as variable.

These contrary winds do not shift from one point to its opposite all at once; in some places the time of the change is attended with calms, in others by variable winds; and it often happens on the shores of Coromandel and China, towards the end of the moonsoon, that there are most violent storms, greatly resembling the hurricanes in the West Indies, wherein the wind is so vastly strong, that hardly any thing can resist its force.

All navigation in the Indian ocean must necessarily be regulated by these winds; for if mariners should delay their voyages till the contrary monsoon begins, they must either sail back, or go into harbour, and wait for the changing of the trade winds.

Vapours rising from the sea, and by the wind carried over low lands to the ridges of mountains, and compelled to mount up with the stream of the air to the tops, where the water presently precipitates gleeting down by the chinks and cliffs of the stones, and part of the water entering into the caverns of hills, and gathering into basons, which being once filled begin to run over, and form subterraneous passages through the earth, breaking out in springs by the sides of hills; several of those meeting together form rivulets; several of these rivulets meeting together make a river. This, together with what is incorporated into vegetables, renders it impossible for all the water evaporated from the sea to return to it again.

Hence the evaporations arising from the Mediterranean are such, that notwithstanding there are 9 capital rivers, which empty themselves into it, besides smaller ones, there is a constant current running through the Straits of Gibraltar from the Atlantic ocean, to make up the deficiency. R. Mead, M. D. and F. R. S. observes,

1. That

1. That some diseases are properly the effects of the influence of the heavenly bodies. 2. That the most windy seasons of the year are about the vernal and autumnal equinoxes. 3. All the changes we have enumerated in the atmosphere do fall out at the same times when those happen in the ocean, and, as both the waters of the sea and the air of our earth or fluids, are subject in a great measure to the same laws of motion, so that natural effects of the same kind are owing to the same causes. 4. The alteration made by the sun and moon in the atmosphere must thereby have influence on the animal body. 5. The elasticity of the air is of great moment, and it is reciprocally as the pressure, so that the incumbent weight being diminished by the attraction, the air underneath will be much expanded; these, and such like causes, will make the tides in the air to be much greater than those of the ocean; and there is no doubt to be made, but that the same infinite wise Being, who contrived the flux and reflux of the seas, to secure that vast collection of waters from stagnation and corruption, has ordered this ebb and flood of the air of our atmosphere with the like good design; that is, to preserve it sweet, and a brisk temper of this fluid so necessary to life, by a continual circulation. 6. Two contrary winds blowing towards the same place, may accumulate the air there, so as to increase the height and the weight of the incumbent cylinder; in like manner the direction of two winds may be such, as meeting at certain angles, may keep the gravity of the air in a middle state; but if the wind blow different ways from the same place (which may be occasioned by thunder and lightning) the height and weight of the air may be much decreased. 7. The changes in our atmosphere at high water, new and full moon, the equinoxes, &c. must occasion alterations in all animal bodies, for all living creatures require air of a determined gravity to perform respiration easily; for it is by its weight that this fluid insinuates itself into the cavity of the breast and lungs: By a slow circulation the secretion of the spirits is diminished; and, by the want of the force of elasticity and gravity, the juices begin to ferment, change the union of their parts, break their canals, and diseases follow.

Besides the above causes, the atmosphere may be put in motion by the elastic vapours forced from the bowels of the earth by subterraneous heats, and condensed by whatever causes in the atmosphere. A mixture of effluvia of different qualities in the air may, by rarefaction, fermentation, &c. produce winds and other effects like those resulting from the combination of some chymical liquors; and that such things happen, we are assured from the nature of thunder, lightning, and meteors. From the eruptions of volcanoes and earthquakes in distant places, wind may be propagated to remoter countries. The divided or united forces of the other planets and of the comets, may variously disturb the influence of the sun and moon, &c. We know that there happen violent

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tempests

tempests in the upper regions of the air, when we below enjoy a calm, and how many ridges of mountains there are on our globe which interrupt and check the propagation of the winds, so that it is no wonder that the phænomena we have ascribed to the action of the sun and moon are not always constant and uniform, and that every effect does not hereupon follow: which, were there no other powers in nature able to alter the influence of, this might in a very regular and uniform manner be expected from it.

That the rarefied air ascends is sufficiently demonstrated by the aerostatic globe, or air balloon, lately invented; this is a globe made of silk, or other light stuff, made air tight with gum; which being filled with inflammable, or rarefied air, will, when let loose, ascend until it comes to that part of the atmosphere that is nearly as light as the air within it, where it will continue some time.

Some of these globes have been made so large as to carry up men with them, as have frequently been seen in Britain, France, and other parts.

NOTE. The swiftness of wind in a great storm is not more than 50 or 60 miles in an hour, and a common brisk gale is about 15 miles an hour.

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## T I D E S.

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**A** TIDE is that motion of the water in the seas and rivers, by which they regularly rise and fall: the general cause of which was discovered by Sir ISAAC NEWTON, and is deduced from the following considerations:—Daily experience shews, that all bodies, when thrown upwards from the earth, fall down to its surface in perpendicular lines; and as lines perpendicular to the surface of any sphere tend towards its centre, the lines, along which all heavy bodies fall, must be directed towards the earth's centre.

As bodies appear to fall by their weight, or gravity; the law, by which they descend, is called the law of gravitation: and as a magnet or loadstone, will draw small portions of iron or steel, and as a piece of glass, amber, or sealing-wax, when warmed by rubbing, will draw small bits of paper and other light substances, the law, by which such bodies fly to those which draw them, is called the law of attraction. Hence it is not improper to say, that bodies



when falling by their gravity towards the earth, are *attracted* by the earth; and therefore, the words gravitation and attraction may, respecting the earth, be used indifferently, as by them is only meant that power, or law, by which all bodies tend towards its centre.

Sir ISAAC discovered, by a great number of observations, that this law of gravitation or attraction was universally diffused throughout the solar system; and that the regular motions, observed among the heavenly bodies, were governed by it; so that the earth and moon attract each other, and both of them are attracted by the sun. He also discovered, that the force of attraction, mutually exerted by these bodies, was lessened as the distance increased, in proportion to the squares of those distances; that is, the power of attraction, at double the distance, was four times less; at triple the distance, nine times less; at quadruple the distance, sixteen times less, and so on.

As the earth is attracted by the sun and moon, it follows, that all the parts of the earth will not gravitate towards its centre in the same manner as they would do, if those parts were not affected by such attractions. And it is evident, that were the earth entirely free from such actions of the sun and moon, the ocean, being on all sides equally inclined towards its centre by the force of gravity, would continue in a perfect stagnant state, without ever ebbing or flowing. But, as the case is otherwise, the water in the ocean must needs rise higher in those places where the sun and moon diminish its gravity, or where they have the greatest attraction.

As the force of gravity must be diminished most, in those parts of the earth to which the moon is nearest, or in the zenith, because her attraction will there be most powerful; therefore the waters, in such places, will rise higher, and it will in them be full sea or high-water. The parts of the earth directly under the moon, and also those in her nadir, viz. such places as are diametrically opposite to those where the moon is in the zenith, will have high-water at the same time. For either half of the earth would gravitate equally towards the other half, were they free from all external attraction. But, by the action of the moon, the gravitation of one half of the earth towards its centre is diminished, and that of the other increased. In the half-earth next the moon, the parts directly under her being most attracted, and consequently their gravitation towards the earth's centre most diminished, the waters in these parts must be higher than in any other part of this half-earth. And in the half-earth, farthest from the moon, the parts in the nadir being less attracted by her than those which are nearer, gravitate less towards the earth's centre, and consequently, the waters in those parts, must be higher than they are in any other part of this half-earth.

Those parts of the earth, where the moon appears in the horizon, or is 90 degrees distant from the zenith and nadir, will have their

lowest waters. For as the waters in the zenith and nadir rise at the same time, the adjacent waters will press towards those places to restore the equilibrium; and, to supply the places of these, others will move the same way, and so on to  $90^\circ$  distant from the said zenith and nadir: consequently the waters, in those places where the moon appears in the horizon, will have most liberty to descend towards the centre; and therefore they will, in such places, be the lowest. Hence it plainly follows, that the ocean if it covered the surface of the earth, would put on a spheroidal, or egg-like figure; in which the longest diameter would pass through the place where the moon is vertical; and the shortest where she is in the horizon. And as the moon apparently shifts her position from east to west in going round the earth every day, the long diameter of the spheroid, following that motion, would occasion the two floods and ebbs in about every 25 hours, which is about the length of a lunar day, or the time spent between the moon's leaving the meridian of any place, and her coming to it again. Hence, the greater the moon's meridian altitude is at any place, the greater will those tides be which happen when she is above the horizon; and the greater her meridian depression is, the greater will those tides be which happen when she is below the horizon. The summer day, and the winter night tides, have a tendency to be highest; because the sun's summer elevation, and his winter depression are greatest: this is more especially to be observed when the moon has north declination in summer, and south declination in winter.

The time of high water is not precisely at the time of the moon's coming to the meridian, but about an hour after. For the moon continues to act with some force after she has past the meridian, and by that means adds to the libratory, or waving motion, which she put the water into whilst she was on the meridian; in the same manner as a small force applied upwards to a ball, already raised to some height, will raise it still higher. The tides are greater than ordinary twice every month; that is, about the times of new and full moon: they are called spring-tides. At these times the sun and moon concur to draw in the same right line; and therefore the sea must, under such joint influence, be more elevated than at other times. During the time of their conjunction, or whilst they are on the same side of the earth, they both conspire to raise the water in the zenith, and consequently in the nadir: and when the sun and moon are in opposition, that is, when the earth is between them, whilst one makes high-water in the zenith and nadir, the other does the same in the nadir and zenith. The tides are less than ordinary twice every month; that is, about the times of the first and last quarters of the moon; these are called neap-tides: because in the quarters of the moon, the sun raises the water where the moon depresses it, and depresses where the moon raises the water; so that the tides are then caused only by the difference of their actions. Here it is necessary

necessary to observe, that the spring-tides happen not exactly at the new and full moons, but generally three days after, when the attracting powers of the sun and moon have conspired for a considerable time. In like manner the neap tides happen about three days after the quarters, when the moon's attraction has been lessened by that of the sun for several days together.

When the moon is in her *perigæum*, or nearest approach to the earth, the tides rise higher than they do, under the same circumstances, at other times; for, according to the laws of gravitation, the moon must attract most, when she is nearest the earth. The spring-tides are greater about the time of the equinoxes, that is, about the latter end of March and September, than at other times of the year; and the neap tides are then less: because the longer diameter of the spheroid, or the two opposite floods, being then in the earth's equator, will describe a great circle of the earth; by the diurnal rotation of which, those floods will move swifter, describing a great circle in the same time they used to describe a less one, parallel to the equator; and consequently, the waters being thrown more forcibly against the shores, must cause them to rise higher.

The following observations have been made on the rise of the tides; namely, the morning-tides generally differ in their rise from the evening-tides. The new and full-moon spring tides rise to different heights. In winter the morning-tides are highest. In summer the evening-tides are highest. Thus it appears, that, after a period of about six months, the order of the highest tides are inverted; that is, the rise of the morning and evening-tides will change places, the winter morning high-tides becoming the same as the summer evening high-tides. Some of these effects arise from the different distances of the moon from the earth after a period of six months, when she is in the same situation with respect to the sun; for, if she be in perigee at the time of the new-moon, she will, in about six months after, be in perigee about the time of full-moon. These particulars being well known, a pilot may chuse that time which will prove most convenient for conducting a ship out of any port, where there is not a sufficient depth of water on common spring-tides.

Small inland seas, such as the Mediterranean and Baltic, are little subject to tides; because the action of the sun and moon is always nearly equal at the extremities of such seas. The tides, in very high latitudes also, are very inconsiderable: for the sun and moon acting towards the equator, and always raising the water towards the middle of the torrid zone, the neighbourhood of the poles must consequently be deprived of those waters, and the sea, within the frigid zones must be low in comparison to other parts.

All the things hitherto explained would exactly obtain, were the whole surface of the earth covered with sea. But since there are a multitude



multitude of islands, besides continents lying in the way of the tide, which interrupt its course; therefore there arise, in many places near the shores, a great variety of other appearances, besides the foregoing ones, which require particular solutions, in which the situations of the shores, straits, shoals, winds, and other things, must necessarily be considered. For instance; as the sea has no visible passage between Europe and Africa, let them be supposed one continent, extending from  $70^{\circ}$  north, to  $34^{\circ}$  south: the middle of those two would be in latitude 19 degrees north, near Cape Blanco on the west coast of Africa. But it is impossible the flood-tide should set to the westward, upon the western coast of Africa, (for the general tide, following the course of the moon, must set from east to west) because the continent for above  $50^{\circ}$ , both northward and southward bounds that sea on the east; and therefore if any regular tide proceed from the motion of the sea from east to west, should reach this place, it must be either from the North of Europe southward, or from the South of Africa northward.

This opinion is further corroborated, or rather fully confirmed, by common experience, which shews that the flood-tide sets to the southward along the west coast of Norway from the North Cape to the Naze, or entrance of the Baltic Sea, and so proceeds to the southward along the east coast of Great Britain, and in its passage supplies all those ports which lie in its way one after another. The coast of Scotland has the tide first, because it comes from the northward to the southward. On the full and change days, it is high-water at Aberdeen at 12 h. 45 m. but at Timmouth Bar not till 3 h. Rolling thence to the southward, it makes high-water at the Spurn a little after 5 h. at Yarmouth Roads a little after 8 h. at Harwich at 10 h. 30 m. at the Nore 12 h. and at London 2 h. 30 m. all in the same day. And although this may seem to contradict the hypothesis of the natural motion of the tides being from east to west, yet as no tide can come west from the main continent of Norway or Holland, it is evident the tide we have been tracing, by its several stages from Scotland to London, is supplied by that tide, the original motion of which is from east to west. As water always inclines to the level, it will in its passage fall to any other point of the compass, to fill up vacancies where it finds them; and yet not contradict, but rather confirm the first hypothesis.

While the flood-tide is thus gliding to the southward along the east coast of England, it also sets to the southward along the west coasts of Scotland and Ireland; one branch of it falls back, north-east into St. George's Channel; and another runs between Ushant and the Lizard, into the British Channel. Some may object that this course of the flood-tide, east up the Channel, is quite contrary to the hypothesis of the general motions of the tides being from east to west; and consequently of its being high-water where the moon is vertical, or any where else on the meridian. But it may

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be answered, that this particular direction of the tides does not contradict the general direction of the whole. A river with a western course may supply canals which wind north, south, or even east, and yet the river keep its natural course; and if the river ebbs and flows, the canals supplied by it would also do the same, although they did not keep exact time with the river; because it would be flood, and the water advanced to some height in the river, before it reached the farthest part of the canals; and the more remote the extremity of the canals are, the longer time it would require: it may also be added; that if it were high-water in the river just when the moon was on the meridian, she would be far past it before it could be high-water in the remotest part of those canals; and the flood would set according to the course of the canals that received it, and could not set west upon a canal of a different position. As St George's Channel, the British Channel, &c. are no more in proportion to the vast ocean, than such canals would be to a large navigable river; it will evidently follow, that the flood-tide may, among those obstructions and confinements, set upon any other point of the compass, as well as west; and may make high-water at any other time, as well as when the moon is upon the meridian, without anywise contradicting the general theory of the tides.

Among pilots it is customary to reckon the time of high-water by the point of the compass the moon bears on at that time, allowing three quarters of an hour for each point. Thus, in places where it is high-water at noon, on the full and change days the tide is said to flow north and south, or 12 o'clock. In places where the moon bears 1, 2, 3, 4, or more points to the eastward or westward of the meridian, when it is high-water on such days, the tide is said to flow on such a point; so, if the moon bears south-east at high-water, it is said to flow south-east and north-west, or 9 o'clock; if she bears south-west, it flows south-west and north-east, or 3 o'clock; and in like manner for every other point of the moon's bearing.

From the observations of many persons, the times of high-water on the days of the new and full-moon on most of the coasts of Europe, and several other places, have been collected; and those are generally put in a table, against the names of their respective places, in an alphabetical order; hence it is called the tide table.

The method generally prescribed for finding the time of high-water at any place, is contained in the following particulars:

*To find the Leap-Year.*

Divide the given year by 4, if nothing remains it is leap-year, but if 1, 2, or 3 remains, they shew that it is so many years after bissextile, or leap-year, as the remainder is: thus, the year 1796 divided

divided by 4, gives 449, and the remainder is 10) shews it is leap year.

*To find the Golden Number for any Year.*

**RULE.** Add one to the given year, and divide the sum by 19 the remainder will be the golden number.

### E X A M P L E.

*Required the Golden Number of 1796?*

By adding one to that year, it gives 1797, this divided by 19, gives 94 for the quotient, and the remainder is 11, the golden number for 1796.

*To find the Epact for any Year.*

**NOTE.** The Epact is the moon's age at the beginning of the year, or rather the first of March. The Epact advances 11 every year, to 30, because the solar year is 11 days longer than the lunar year, and as the Epact increases, it shews the moon's age at the beginning of the year; it is here supposed, that at the end of 19 years, the sun and moon make all the variety of situations they possibly can with one another, and thence begin, and go over the same again. The golden number at the birth of Christ, was 1, which is the reason that one is added to the given year, to find the golden number.

**RULE.** Divide the given year by 19, the remainder multiply by 11, and the product will be the Epact, if it does not exceed 29; but if it does, subtract 30 from it as often as you can, and the remainder will be the Epact, for it never exceeds 29.

### E X A M P L E.

*What is the Epact of the Year 1796?*

1796 divided by 19, gives 94, and the remainder 10 multiplied by 11, gives 110; this divided by 30, gives 3, and the remainder is 20; which is the Epact for 1796.

*To find the Moon's Age.*

To the Epact, add the days of the month, and the Epact, or number for the month; the sum if it does not exceed 30 is her age; but if it does, subtract 30 from it as often as you can, and the remainder is her age.

**NOTE.** The Epact or number for each month, is found thus: divide the number of days contained between the first of January and the first day of any month, by  $29\frac{1}{2}$ , the remainder will be the number for that month.

Required the Number or Epact for Sept. 1796?—*Ans.* 7.5.

The number of days contained between the first of January 1796, and first of Sept. are 244 days, divided by  $29\frac{1}{2}$ , gives 8 for the quotient, and 8 for the remainder, which is the number sought; and so for any other month.

### E X A M P L E.



## EXAMPLE.

Required the Moon's Age, April 29, 1796.

Day of the month           29  
 Epact for the year       20  
 Number for the month     3

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30) 52 (1  
 30

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22 Moon's age.

Numbers for the Months are nearly as follows :

|               | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---------------|------|------|------|------|------|-------|-------|------|------|------|------|------|
| In com. years | 0    | 2    | 0    | 2    | 2    | 4     | 4     | 6    | 7    | 8    | 10   | 10   |
| In leap years | 0    | 2    | 1    | 3    | 3    | 5     | 5     | 7    | 8    | 9    | 10   | 11   |

*To find the Moon's Southing on any Day of her Age.*

Since the sun returns to the meridian he has left in the space of 4 hours, and the moon in about 24 hours 49 minutes ; therefore, if the moon leaves the meridian at the same time that the sun does, on any day, the next day she will come to the meridian 49 minutes after him, falling back, about 49 minutes every day ; whence to find the time of the moon's southing, or coming to the meridian on any day, we have this easy RULE :

Multiply the day of her age by 49, and divide the product by 60, the quotient is the hours, and the remainder the minutes afternoon when she souths. Or, which is rather easier, and in many respects sufficiently exact for the mariner's purpose ; multiply the moon's age by 4, and divide the product by 5, the quotient is the hours, and the remainder multiplied by 12, gives the minutes afternoon when she is upon the meridian ; but if this time exceeds 12, subtract 12 hours from it, and the remainder is the time of her southing in the morning.

N. B. From the full moon to the change she comes to the meridian, or souths in the morning ; but from the change to the full, in the afternoon.

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EXAMPLE.

## E X A M P L E.

Required the Moon's Southing, August 25, 1796?

|                         |                  |                 |             |
|-------------------------|------------------|-----------------|-------------|
| The epact is            | 20               | Or thus         | 22          |
| Number for the month is | 7                |                 | 4           |
| Day of the month        | 25               |                 | <u>5)88</u> |
|                         | <u>30)52(1</u>   |                 |             |
|                         | 30               | Moon's southing | 17 36       |
|                         |                  |                 | 12 00       |
| Moon's age              | 22               |                 | <u>5 36</u> |
|                         | 49               |                 |             |
|                         | <u>198</u>       |                 |             |
|                         | 88               |                 |             |
|                         | <u>6,0)107,8</u> |                 |             |
| Moon's southing         | 17 58 afternoon  |                 |             |
| Subtract                | 12,              |                 |             |

Moon's southing 5 58 in the morning.

Hence it appears that the moon comes to the south at 58 minutes after 5 in the morning.

*To find the Time of High Water on any Day of the Moon's Age at any Place.*

From the observations of many persons, there have been collected the times when it is high water on the days of the new and full moon, on most of the sea coasts of Europe, and at several other places, and these times are commonly put in a table against the names of the places in an alphabetical order, for which reason, it is called the Tide Table; but in this treatise, the times of high water at full and change days, are set down after the latitude and longitude of each place, in the table of latitudes and longitudes of places.

RULE. To the time of the moon's southing on the given day add the time of high water at the full and change at the given place taken from the table; the sum is the hour past noon on the given day, when it is high water at that place; and if this hour exceeds 12, subtract 12 from it, and the remainder shews the time of high water in the morning; but if it exceeds 24, subtract 24 from it, and the remainder shews the time of high water in the afternoon.

EXAMPLE

## EXAMPLE I.

At what Time will it be High  
Water at London, August  
25, 1796?

19)1796(94  
171

86

76

10

11

30)110(3  
90

The epact 20  
Num. of month 7  
Day of month 25

Subtract 52  
30

Moon's age 22  
Multiply by 4

5)88(3

17=36

Time at London 3

Afternoon 20 36  
Subtract 12

Morning 8 36

## EXAMPLE II.

Required the Time of High Wa-  
ter at Dover, October 12,  
1796?

19)1796(94  
171

86

76

10

11

30)110(3  
90

Epact 20  
Num. of month 9  
Day of month 12

41  
30

Moon's age 11  
49

60)539(8  
480

59

Moon's Southing 8 59  
Time at Dover 10 30

Afternoon 19 29  
Subtract 12

So that it is high water 36 minutes after eight  
in the morning at London. Morning

7 29



## EXAMPLE.

Required the Time of High Water at the Start Point, Jan. 3, 1796.

|                 |       |
|-----------------|-------|
| Epact           | 20    |
| Day of month    | 3     |
| Num. of month   | 0     |
|                 | <hr/> |
| Moon's age      | 23    |
|                 | 4     |
|                 | <hr/> |
|                 | 5)92  |
|                 | <hr/> |
| Moon's southing | 18 24 |
| Time at Start   | 6     |
|                 | <hr/> |
|                 | 24 24 |
|                 | 24    |
|                 | <hr/> |
| H. W. afternoon | 00 24 |

Hence it appears that it is high water at the Start at 24 minutes in the afternoon.

*Coming into a Port and find that it is High Water at a certain Hour, to know when it is High Water there on Full and Change Days?*

**RULE.** Find the time of the moon's southing on that day, and subtract from it the time of high water at the given place, if you can, and the remainder will be the time of high water on the full and change days of the moon; if you cannot, add 12 hours to it, and subtract the above time from the sum; the remainder will be the time of high water at that port on the full and change days.

This is the method of finding the time of high water inserted in common books of navigation, which, at times, will give the moon's age, whole days and the time of southing, and of high water, hours wide of the truth; and even if the moon's southing be exactly found, yet the tides may differ less or more from the computed time; for the floods do not always happen at the same distance of time from each other, but at different distances, according to the times of the moon's age, and her aspect with respect to the sun; or as the waters are acted upon by the sum or difference of the attractive forces of the sun and moon, and also on account of winds and storms, even when out of hearing, which greatly affected the tides, the real time of high water at any place will often differ from the computed times; therefore pilots and all concerned, would do well to use the following method, which will in general, give the time of high water within half an hour of the truth, when the tides are not greatly influenced by the wind.

A TABLE

A TABLE for the ready finding the Day of the Month the *New Moon* will fall till the Year 1900, and consequently the *Moon's Age*, for any Day, by knowing the Golden Number, according to the Method commonly used for finding the Moon's Age.—Add 1 to the given Year, and divide the Sum by 19, the Remainder will be the Golden Number, which, being marked with Pencil at the top of the Table, will shew the Golden Number during that Year.

|    | Ja. | Feb. | Ma. | Ap. | May  | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Moon's Age. | Times Anf.                                            |
|----|-----|------|-----|-----|------|------|------|------|------|------|------|------|-------------|-------------------------------------------------------|
|    | N M | N M  | N M | N M | N M  | N M  | N M  | N M  | N M  | N M  | N M  | N M  |             | High Water later each Day after the New & Full Moons. |
|    |     |      |     |     |      |      |      |      |      |      |      |      | Days        | H. M.                                                 |
| 1  | 29  | 28   | 29  | 28  | 27   | 26   | 25   | 24   | 23   | 22   | 20   | 20   | 1           | 0 44                                                  |
| 2  | 18  | 17   | 19  | 17  | 17   | 16   | 15   | 13   | 12   | 11   | 10   | 9    | 2           | 1 22                                                  |
| 3  | 8   | 6    | 7   | 5   | 5    | 3    | 3    | 2    | 1.30 | 29   | 28   | 27   | 3           | 1 56                                                  |
| 4  | 26  | 25   | 27  | 25  | 25   | 23   | 22   | 20   | 19   | 8    | 17   | 17   | 4           | 2 28                                                  |
| 5  | 15  | 14   | 16  | 15  | 14   | 13   | 12   | 10   | 8    | 8    | 6    | 6    | 5           | 3 2                                                   |
| 6  | 4   | 3    | 5   | 3   | 3    | 1    | 1.30 | 29   | 27   | 27   | 25   | 25   | 6           | 3 40                                                  |
| 7  | 23  | 22   | 22  | 21  | 20   | 19   | 18   | 17   | 16   | 15   | 14   | 13   | 7           | 4 24                                                  |
| 8  | 12  | 10   | 12  | 10  | 10   | 8    | 8    | 6    | 5    | 4    | 3    | 3    | 8           | 5 12                                                  |
| 9  | 1   | —    | 1   | 29  | 29   | 27   | 27   | 25   | 24   | 23   | 22   | 21   | 9           | 6 4                                                   |
| 10 | 20  | 18   | 20  | 19  | 18   | 17   | 16   | 15   | 13   | 13   | 11   | 11   | 10          | 7 8                                                   |
| 11 | 9   | 8    | 8   | 7   | 6    | 5    | 4    | 4    | 2    | 1    | 29   | 29   | 11          | 8 24                                                  |
| 12 | 27  | 26   | 27  | 26  | 25   | 24   | 23   | 22   | 20   | 20   | 18   | 18   | 12          | 9 18                                                  |
| 13 | 17  | 15   | 17  | 15  | 15   | 13   | 13   | 11   | 10   | 9    | 8    | 7    | 13          | 10 26                                                 |
| 14 | 6   | 4    | 6   | 5   | 4    | 3    | 2    | 1.30 | 29   | 28   | 27   | 26   | 14          | 11 32                                                 |
| 15 | 25  | 23   | 24  | 22  | 22   | 20   | 20   | 19   | 17   | 17   | 15   | 15   | 15          | 12                                                    |
| 16 | 13  | 12   | 13  | 12  | 11   | 10   | 9    | 8    | 6    | 6    | 4    | 4    | 16          | 1 0                                                   |
| 17 | 3   | 1    | 3   | 1   | 1.30 | 29   | 28   | 27   | 25   | 25   | 23   | 23   | 17          | 1 24                                                  |
| 18 | 22  | 20   | 22  | 20  | 20   | 18   | 18   | 16   | 15   | 14   | 13   | 12   | 18          | 2 8                                                   |
| 19 | 11  | 9    | 10  | 8   | 8    | 6    | 6    | 5    | 3    | 2    | 1    | 1.30 | 19          | 2 40                                                  |

From the Change to the Full, the Moon comes to the Meridian in the Afternoon; and from the Full to the Change, she comes to the Meridian after Midnight.

The use of the foregoing table.

To find the moon's age on any given day, look in the first column (marked Gn. N<sup>o</sup>.) for the golden number, and under the month, on the same line, stands the day of the new moon; then count the days which have completely passed since the last change, and they will be her age on the given day.

*To find the Time of High Water.*

Look for the moon's age in the table of times, and the hours and minutes opposite to which being added to the time of high water, on the change and full days, at any place, will, if it does not exceed 12 hours, give the time of high water there in the afternoon of the given day; but if it does exceed that number, take 12 from it, and the remainder will shew the time of high water in the morning.

E X A M P L E I.

*At what time will it be High Water at London, April 29, 1796?*

Opposite 11 the golden number, and under April, I find it was new moon the 7th day; and reckoning forward to April 29, gives 22 days for the moon's age.

Against 22, in the table of times, stand 4 hours 36 minutes, to which add 3 hours, the time of high water at London on the full and change days, and that gives 7 hours 36 minutes, the time of high water at London in the morning; differing one hour from that found in the first example by the common method.

E X A M P L E II.

*Required the Time of High Water at Dover, October 12, 1796?*

Opposite to 11 the golden number, and under October, I find it was new moon the 1st day; reckoning forward to October 12, I find the moon's age is 11 days; against 11 in the table of times stand 8 hours and 8 minutes. This added to 10 hours 30 minutes, the time of high water on full and change days at Dover, gives 18 hours 38 minutes; from which I take 12, and the remainder 6 hours 38 minutes is the time of high water in the morning at Dover on the given day; differing from that found in the second example by the common method, 41 minutes.

E X A M P L E III.

*What Time will it be High Water at Torbay, July 10, 1796?*

By the tables it was new moon on the 4th day, and reckoning forward to the 10th, I find there are 5 days completely past. Against 5 in the table of times, stand 3 hours 2 minutes, which added to 6 hours the time of high water at Torbay, on full and change days, gives 9 hours 2 minutes the time of high water in the afternoon, on the above day; differing from that given by the former method, 58 minutes.



*To find the Time of the Moon's Rising.*

If the moon is not yet come to the full, add the time of her southing to the time of the sun's rising, and the sum will be the time of the moon's rising in the forenoon; but if the sum exceeds 12, subtract 12, and take the remainder for the time of her rising in the afternoon. But if the moon is past her full, then add the time of her southing to the time of the sun's setting, and the sum will be the time of the moon's rising in the afternoon. But if the sum exceed 12, subtract 12, and take the remainder for the time of the moon's rising in the morning.

NOTE. If the time of the sun's rising and setting is not known, it may be easily found, having the latitude of the place and the sun's declination in the table, shewing the rising and setting of the sun, moon, or stars.

At London, Dec. 1, 1792, required the Time of the Moon's Rising?

|                                     | H. | M.            |
|-------------------------------------|----|---------------|
| Rising                              | 12 | 00            |
| Sun rises that day by the tables at | 8  | 02            |
| <hr/>                               |    |               |
| Sun sets                            | 3  | 58            |
| Moon souths that day at             | 2  | 24            |
| <hr/>                               |    |               |
| Moon rises at                       | 6  | 22 afternoon. |

*To find the Time of the Moon's Setting.*

Find the time of the sun's rising and setting by the tables as before, and if the moon is not yet come to the full, add the time of her southing to the time of the sun's setting, and the sum will be the time of the moon's setting in the afternoon; but if the sum exceeds 12, subtract 12, and take the remainder for the time of her setting in the morning.

And if the moon is past the full, add her southing to the time of the sun's rising, and the sum will be the time of the moon's setting in the morning; but if the sum exceeds 12, subtract the 12, and take the remainder for the time of the moon's setting in the afternoon.

EXAMPLE.

## EXAMPLE.

At London, Nov. 16, 1792, required the Time of the Moon's Setting.

|                                        | H. | M.            |
|----------------------------------------|----|---------------|
| Setting                                | 12 | 00            |
| Sun rises Nov. 16th, by the tables, at | 7  | 43            |
| Sun sets                               | 4  | 17            |
| Moon souths Nov. 16th                  | 1  | 36            |
| Moon sets Nov. 16th at                 | 5  | 53 afternoon. |

NOTE. The above method may differ half an hour from the time given by the almanacs.

In like manner may the time of high water be found at any other place. Whoever will compare these examples with the methods used in other books of this kind, will find a considerable difference, as they frequently give the moon's age several days, and of high water, hours wide of the truth; indeed, on account of the irregularities of the moon's motion, the times of her change may differ half a day from the truth; and the time of high water 30 minutes, but seldom more, if the sea is not greatly influenced by the wind.

The tides do not always answer to the same distance of the moon from the meridian at the same places, but are variously affected by the action of the sun, which brings them on sooner when the moon is in her first and third quarters; and keeps them back later when she is in her second and fourth quarters; because in the former case, the tides raised by the sun alone, would be earlier than the tide raised by the moon; and in the latter case later, as may be seen in the table of the shifting of the tides.

As the Nautical Almanac is become now of general use in long voyages, the time of high water at any part of the world may be readily found, if the time making high water at full and change be known; for in the sixth page of each month is given the time of the moon's passage over the meridian of Greenwich every day: this time may be reduced to the meridian of any other place, by allowing 1 hour for every 15 degrees of longitude. To this time add the time making high water there, on full and change days, which gives the time of high water nearly on that day, if the sum be less than 12 hours; but if above, subtract 12 hours, or 24 hours from it; observing, that the days in this Almanac begin 12 hours later than the common day.

ATABLE

*A TABLE of the Bearings of the MOON at the Time of High Water, nearly with the Times of those Bearings at the following Places:*

| When the Moon bears as follows. |             | H.               |                                                                                                                                                 |
|---------------------------------|-------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| N. and                          | S.          | 12               | { Isle of Alderney, Gibraltar, Southampton, Beachy; Sheerneys, a Sand called Kentish Knock, a Sand called the Swin, at the Mouth of the Thames. |
| N. by E.                        | S. by W.    | 0 $\frac{1}{4}$  | { or 45 minutes past 12, Rochester, Flushing, Malden, Nore.                                                                                     |
| N. N. E.                        | S. S. W.    | 1 $\frac{1}{2}$  | { or 30 minutes past 1, Bell Isle, Timmouth, Gravesend, Holyhead.                                                                               |
| N. E. by N.                     | S. W. by S. | 2 $\frac{1}{4}$  | { or 15 minutes past 2, Berwick, Lisbon, St. Andrew's, Couquet.                                                                                 |
| N. E.                           | S. W.       | 3                | { Whitby, London, Amsterdam, Bourdeaux, Bay of Biscay.                                                                                          |
| N. E. by E.                     | S. W. by W. | 3 $\frac{3}{4}$  | { Brest, Huntcliff, Isle of Bas, at the Maes Scarborough.                                                                                       |
| E. N. E.                        | W. S. W.    | 4 $\frac{1}{2}$  | { In Bresound, Ushant, Scilly, Cork, C. Clear,                                                                                                  |
| E. by N.                        | W. by S.    | 5 $\frac{1}{4}$  | { Humber Mouth, at the Spurn, Torbay, Start Point.                                                                                              |
| E.                              | W.          | 6                | { Hull, Wells, Weymouth, Plymouth, Ramhead, Torbay, Dartmouth.                                                                                  |
| E. by S.                        | W. by N.    | 6 $\frac{3}{4}$  | { Bristol, Portland Rd. Lynn, Foulness, Foy.                                                                                                    |
| E. S. E.                        | W. N. W.    | 7 $\frac{1}{2}$  | { Lizard, Land's End, Falmouth, Penryn, C. Barfleur.                                                                                            |
| S. E. by E.                     | N. W. by W. | 8 $\frac{1}{4}$  | { Eddystone, Yarmouth, Needles, Fly, Dublin, Isle of Ely.                                                                                       |
| S. E.                           | N. W.       | 9                | { Isle of Man, Isle of Wight, E. End, Caskets, Caen, St. Helen's.                                                                               |
| S. E. by S.                     | N. W. by N. | 9 $\frac{3}{4}$  | { North Foreland, Dungeness, Dunnose, Shoreham.                                                                                                 |
| S. S. E.                        | N. N. W.    | 10 $\frac{1}{2}$ | { Downs, Deal, Dover, S. Foreland.                                                                                                              |
| S. by E.                        | N. by W.    | 11 $\frac{1}{4}$ | { Margate, Harwich, Rose, Pool, Portsmouth, Spithead, Calais.                                                                                   |
| S.                              | N.          | 12               | { Dunkirk, Embden, R. Elbe, Coast of Flanders, Ostend.                                                                                          |

NOTE. The current in the Downs generally runs 7 $\frac{1}{4}$  hours to the north; and 5 $\frac{1}{4}$  hours to the southward; at Dover the tide from the channel runs northward 7 $\frac{1}{2}$  hours; and from the north 5 h. 10 m. at the full and change of the moon. The tides set in the Downs N. N. E. and S. S. W. hourly. It is high water at London 46 minutes after two at full and change by the shore.

Pilots reckon 6 hours for a tide, then as  $\frac{1}{2}$  a tide is 3 hours,  $\frac{1}{4}$  tide is 1 $\frac{1}{2}$  hour, and half-quarter tide is  $\frac{3}{4}$  of an hour. So that if it flows tide, half tide, and quarter tide, it is high water at half an hour after 10 o'clock, which is the case in the Downs by the shore.



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OF THE  
LOG-LINE AND HALF-MINUTE GLASS,  
AND HOW TO  
CORRECT THE DISTANCE GIVEN BY THEM.

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**T**HE Log is a flat piece of wood like a flounder, or of the figure of a quarter of a circle, having its circular side loaded with lead sufficient to make it swim upright in the water. To this log is fastened a long line of about 150 fathoms, called the Log-line, which is divided into certain equal spaces, called Knots, each of which ought to bear the same proportion to a nautical mile (60 of which make a degree) that half a minute does to an hour, that being the time allowed for the experiment.

They are called Knots, because at the end of each of them there is a piece of twine with knots in it, reeved between the strands of the line; these pieces of twine shew how many knots run out in half a minute, and consequently the ship's rate of sailing per hour.

Mr. NORWOOD, and several other able mathematicians, have found that a degree of a great circle upon the earth contains about 367200 English feet, therefore a nautical mile being the  $\frac{1}{60}$  part of 367200 feet, that is, 6120 feet, and since half a minute is  $\frac{1}{120}$  part of an hour, the length of a knot on the log-line ought to be the  $\frac{1}{120}$  part of 6120 feet, or 51 feet. But as for the most part the ship's way is found, by experience, to be really more than that given by the log, and as it is safer to have the reckoning before the ship than after it, therefore 50 feet may be taken as the proper length of each knot, and these knots subdivided into ten fathoms, each of 5 feet, which is certainly the best adapted for practice, and will correspond with all the tables and instruments used in navigation, as they are decimally divided, and consequently, the ship's run determined with greater ease and certainty. But some experienced commanders find, that the allowing 50 feet to a knot, generally makes a ship a-head of the reckoning; and to avoid danger mostly divide the log-line into knots of 7 or  $7\frac{1}{2}$  fathoms of 6 feet each, to correspond with a glass that runs 28 seconds. Others again, divide the seconds the glass runs by 4, and take the quotient for the distance in fathoms between the knots; which of these methods are best, I leave to every captain's own experience to determine; but certain it is, that whatever length the knots are, the most convenient way is to divide them into tenths.

In hot or dry weather, the glass runs out faster than in moist or rainy weather: therefore care should be taken to try what number of seconds the glass runs,

The

The length of the log-line formerly used, was divided into knots of 42 feet, which way of dividing the same was founded on the supposition, that 60 miles, of about 5000 English feet, made a degree; whereas it is abundantly certain, that a degree contains about 73 such miles. It was therefore to be wished, that no line so divided were in use, but very often custom prevails over reason; and although mariners find by experience this length of the knots to be too short, yet some of them, rather than quit the old way, use glasses for half minute ones that run but 24 or 25 seconds, which is but correcting one mistake by another.

The knots commonly begin to be counted at the distance of 10, 12, or 15 fathoms from the log, according to the largeness of the ship, that so the log may be out of the ship's wake when it is thrown overboard before they begin to count, lest the eddies should suck the log after the ship; and for the more ready discovery of this point of commencement, there is commonly fastened at it a piece of red rag; that part of the line between the red rag and the log is called the stray line.

The log and log-line being duly prepared and hove overboard from the poop, or lee-quarter, and the line veered out (by the help of a reel which turns easy, and about which it is wound) as fast as the log will carry it away, or rather as fast as the ship sails from it, will shew how fast the ship has sailed in the given time, or rate of sailing per hour.

The experiment for finding the velocity of the ship is called heaving the log.

Care should be taken to veer out the line as fast as the log takes it, for if the log is left to turn the reel of itself, the log will come home, and deceive you in the reckoning.

In kings' ships, India ships, and some others, the log is hove every hour, but in coasters, and those using short voyages, every two hours.

Here the ship is supposed to move with equal velocity between the times of trying the experiment. But if the gale has not been the same during the whole hour, or time between heaving the log, or if there have been more sail set, or any handed, that so the ship has run more or less in any part of the hour than she did at the time of the experiment; or if it should fall little or more wind at that time, there must be allowance made for it according to the discretion of the artist: Sometimes too when the ship is before the wind, and a great sea setting after her, it will bring home the log; in such cases it is customary to allow one mile in ten, and less in proportion, if the sea be not so great.

Care should also be taken to measure the log-line pretty often, lest it stretch and deceive you in the distance.

The like regard must be had, that the half-minute glass be just 30 seconds; otherwise no account of the ship's way can be kept;

to prove which, if there be no stop watch at hand, let a plummet, of any form or weight, be fastened to a silk string or thread, with a loop to hang on a small pin or nail fastened in any place, so that the plummet may swing freely; let it be  $39\frac{1}{4}$  inches from the end of the loop to the middle of the plummet, and the plummet caused to swing; each of those swings will be a true second of time, always counting every time it passes the perpendicular let fall from the pin, and every time it passes from the perpendicular to the utmost swing will be half a second.

*How to correct the Distance given by the Log-Line and Half-Minute Glass.*

The Distance given by the log may be wrong on three accounts, viz. by an error in the glass, an error in the log-line, or an error in both; for correcting of which take the following cases:

CASE I.

When the log-line is truly divided, and the glass is faulty.

RULE. Say, as the seconds run by the glass are to 30 seconds, so is the distance given by the log to the true distance.

EXAMPLE I.

Suppose a ship runs at the rate of  $7\frac{1}{2}$  knots in the time the glass runs out, but measuring the glass I find it runs 34 seconds; what is the true rate of sailing?

As  $34 : 30 :: 7,5 : 6,6$  miles, the true distance sailed in an hour.

EXAMPLE II.

Suppose a ship runs at the rate of  $6\frac{1}{4}$  knots, but measuring the glass I find it runs only 25 seconds; required the true rate of sailing?

As  $25 : 30 :: 6,5 : 7,8$  miles, the true distance sailed in an hour.

CASE II.

When the glass is true and log-line faulty.

RULE. Say, as 50 feet is to the distance measured between knot and knot, so is the distance run by the log to the true distance

EXAMPLE I.

Suppose a ship runs at the rate of  $6\frac{1}{4}$  knots in half a minute, but measuring the space between knot and knot, I find it to be 56 feet; required the true rate of sailing?

As  $50 : 56 :: 6,25 : 7$  miles, the true distance sailed in an hour.

EXAM-



## EXAMPLE II.

Suppose a ship runs at the rate of  $6\frac{1}{2}$  knots in half a minute, but measuring the space between knot and knot, I find it to be only 44 feet; required the true rate of sailing?

As  $50 : 44 :: 6,5 : 5,72$  miles, the true distance sailed in an hour.

## CASE III.

When both the log-line and glass are faulty.

RULE. Multiply thrice the measured length of a knot by the distance run by the log, the product divided by 5 times the measured time of the glass, will give the true distance run.

## EXAMPLE.

Suppose a ship runs 5 knots of a log-line of 45 feet to a knot, while a glass of 25 seconds is running out; what is the true rate of sailing?

|                               |   |       |
|-------------------------------|---|-------|
| The measured length of a knot | — | 45    |
| Multiplied by                 | — | 3     |
|                               |   | <hr/> |

|                                              |       |
|----------------------------------------------|-------|
| Gives thrice the measured length of a knot   | 135   |
| Which multiplied by the distance run per log | 5     |
|                                              | <hr/> |
|                                              | 675   |
|                                              | <hr/> |

And dividing the product by 5 times the time the glass runs, that is  $5 \times 25 = 125$ , the quotient is 5,4, the number of miles the ship runs per hour.

This rule is only a compound of the two former simple ones, which is contracted a little.

When the glass is faulty, the log-line may be divided as in the annexed table, shewing the length of the knots of the log-line to different glasses.

| Seconds of Glass. | Length of Knots in Feet. |
|-------------------|--------------------------|
| 24                | 40,0                     |
| 25                | 41,8                     |
| 26                | 43,4                     |
| 27                | 45,0                     |
| 28                | 46,8                     |
| 29                | 48,4                     |
| 30                | 50,0                     |
| 31                | 51,8                     |
| 32                | 53,4                     |
| 33                | 55,0                     |
| 34                | 56,8                     |
| 35                | 58,4                     |
| 36                | 60,0                     |

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THE DESCRIPTION AND USE OF  
HADLEY'S OCTANT,  
COMMONLY CALLED  
HADLEY'S QUADRANT.

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THE inventor of this noble instrument is disputed, some say it was first invented by one GODFREY in Philadelphia, and that Mr. HADLEY, then an officer in the royal navy, pirated it from him, and brought it to England, who being the first that made it public, it still bears his name. How far this is true, I cannot say, but certain it is, that two men in different parts of the world, may hit upon one invention at the same time.

This instrument is now so much improved, that angles, whether vertical, horizontal, or any other position, the objects happen to be in, may be taken to such a degree of exactness, that people unacquainted with the use of it would scarcely think possible.

The principles of this admirable instrument has been so well demonstrated by other hands, that a repetition thereof here, seems to me unnecessary; I shall therefore content myself with giving a short description of it, and its use in navigation.

*The principal Parts of the Instrument are,*

The Index D

The Index Glasses E

The Horizon Glasses G and F

The dark Glasses, or Screens H

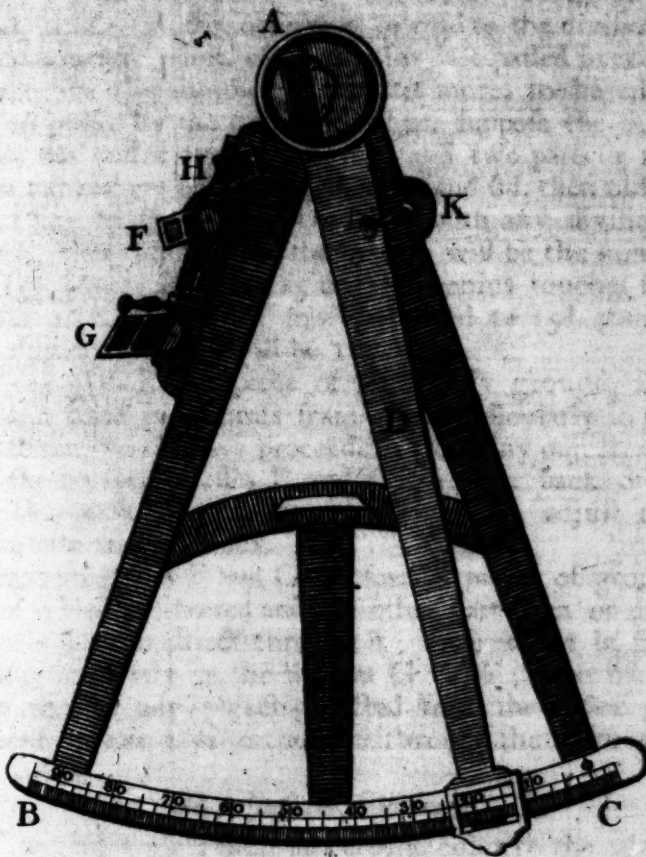
The Sight Vanes K and G

The graduated arch BC contains only 45 degrees, or is the 8th part of a circle, but is to be esteemed as 90°, and so divided, because by the double reflection the angle is doubled.

The divisions run 0, 10, 20, &c. to 90 as in the figure, each degree is divided into 3 parts of 20 minutes each, which by the help of the vernier, or divisions on the index, is again subdivided into minutes of a degree, thus:

The index D is a flat bar moveable on the centre of the instrument, that part of the index that slides over the graduated arch having the first and last divisions thereon corresponding to those on the arch, is called the Vernier or Nonius, and which divides every sub-division on the arch in minutes, thus, 7 divisions on the nonius being divided into 20 parts, it is evident the difference between the first divisions on the arch and on the nonius is  $\frac{1}{20}$  of one of the sub-divisions on the arch, or 1 minute, because 7° there, is divided into 21 parts, being one in 20 greater than on the arch. The difference

# HADLEY'S QUADRANT



The principal Parts of this Instrument are

- The Index* D
- The Index Glass* E
- The Horizon Glasses* G and F
- The dark Glasses or Screens* H
- The Sight Vanes* K and G



# THE UNIVERSAL INSTRUMENT



The Principal Parts of this Instrument

- The Dial Plate
- The Frame
- The Legs
- The Central Rod
- The Circular Window
- The Adjusting Screws
- The Base
- The Hinges
- The Locks
- The Carriage
- The Index
- The Image
- The Notch
- The Indent
- The Pre
- The Arc
- The Seco

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ference of the two first divisions will be 2', and the difference of the three first 3, and so on; hence it will arise, that in whatever divisions on the vernier and arch cut one another the nearest, the vernier will indicate how many minutes above the next sub-division according as it is numbered to right or left thereof. On the bottom of the index against the back of the arch is a screw made to fix fast the index when required.

The arch, as before observed, is divided into 90 degrees numbered 0, 10, 20, 30, &c. and each degree into 3 parts, each 20 minutes, and is to be read thus: 1d.—1d. 20m.—1d. 40m.—2d.—2d. 20m.—2d. 40m.—3d. &c. observing to read to the division that the 0, or diamond-like point, of the nonius last passed over: then the nonius will give the number of minutes more, to be added to the division last passed by the nonius. Thus, suppose the 0, or  $\Delta$  of the nonius has passed over 15 degrees and two parts or 15d. 40m. and stands somewhere between 15d. 40m. and 6d. then observe what division or line on the nonius coincides with any division or line on the arch, that number on the nonius will be the minutes to be added to 15d. 40m. Suppose 15 on the nonius touches some division on the arch, then 15m. must be added to 15d. 40m. and the angle or altitude measured will be 15d. 55m.

The index glass E. is a piece of glass truly ground, silvered on the back and fixed in a brass frame, perpendicularly to the index, its use is to receive the rays proceeding from any object, and reflect them to the horizon glasses F and G; at the back of the brass frame of this glass are two screws, serving to adjust the frame perpendicularly to the index.

The horizon glasses F and G are smaller pieces of ground glass, one part of which is silvered and the other part open or unsilvered, in order to look at an object through it; these are set in frames and placed perpendicularly on the limb at G and F; their use is to receive the rays of any object reflected from the index glass, and again to reflect those rays to the eye through the holes of the sight vanes K and G.

*To adjust the Quadrant.*

First, The index glass must be perpendicular to the plane of the quadrant, which if not, you may thus discover; hold the plane of the quadrant in an horizontal position, with the index glass near the eye, look right down the quadrant in such a manner as to see the arch of the quadrant direct, and at the same time reflected by the index glass; then if the arch seen direct together with its reflected image appear to be in one line, the index glass is truly adjusted; if not it must be rectified by means of the screws placed at the back of the index glass; it is easy to discover which way the inclination is by pressing the index glass with your thumb while you observe the arch.

Secondly, The axis of the horizon glass must be parallel to the axis

axis of the index glass, if not the error is easily discovered and rectified in the fore horizon glass when the index is adjusted, thus bring O on the nonius nearly to O on the graduated arch, and look directly through the sight vane at the moon or any bright star, so as to see the reflected image in the horizontal glass, and the object at the same time through the unsilvered part, then move the index backwards and forwards slowly, and observe if both images coincide or pass behind one another, which if they do, the axis of both are parallel, which if not you should nicely adjust by the two screws placed on the top block of the horizon glass.

If a small piece of coloured glass set in brass be made to turn round to the sight vane occasionally to guard the eye, and the screw turned back, the same correction may be made by using the sun instead of the moon or star.

*To take the Altitude of the Sun by the Fore Observation.*

The sun's image at any time when not much obscured by clouds may be seen as reflected from the unsilvered part of the horizon glass, by looking through the hole in the sight vane; having put the screens down to guard the eye, hold the instrument vertical, and turning towards the sun, direct the sight to that part of the horizon beneath the sun, and moving the index you may bring down the red image of the sun towards the horizon; if the sun's image should be faint you may turn back the screens, and you cannot miss it.

Having brought down the sun's image near the horizon, swing the quadrant backwards and forwards, making your eye the centre of motion, and keep moving the index at the same time till the sun's lower edge just touches the horizon, and you will have the apparent altitude of the sun's lower limb upon the arch of the quadrant at that instant. But this altitude is greatest at twelve o'clock, when the sun is on the meridian, from which the latitude is determined; much time will be saved if you have a good watch well regulated to tell you within a minute or two when to begin your observation, but this apparent altitude requires the four following corrections:

First, The index error, if any, to be added or subtracted.

Secondly, The dip of the horizon.

Thirdly, The sun's semi-diameter and refraction.

These four corrections are necessary to find the true altitude of the sun's centre nearly, the correction of the sun's parallax being so small, that it may always be neglected in determining the latitude.

The back observation is managed the same as the fore observation, only your back must be turned towards the sun, and the screens shifted to the back horizon glass, remembering to subtract the sun's semi-diameter (if the apparent lower limb be taken) and add the dip, subtracting the effect of refraction, and you will have the altitude of the sun's centre.

The



The correction for the index error is thus : Turn down the small knob of brass, placed on the limb, to hinder the index from going off the arch, as it may be in the way. This correction may be accurately estimated by taking the diameter of the sun, moon, or any object before and behind O on the arch ; that is, bring the upper limb of the object to coincide with the lower, and note the angle, then take it on the extra arch, as it is called ; that is, bring the lower limb to coincide with the upper, and note the angle, half the difference of these two angles will be the true correction of the index error.

## E X A M P L E.

Suppose the sun's diameter measures 36 on the arch, and 28 in the extra arch. The difference is 8', half which is the error to be subtracted, because the diameter measures more on the arch, or gives the sun's diameter too much, but had the extra arch given the greater angle, the error would have been additive.

*To take the Altitude of the Moon.*

The moon's altitude may be taken either by the fore or back observation exactly in the same manner as the sun's altitude, only here you must bring the edge of the moon into contact with the horizon, which is round and well defined, whether that be the upper or under edge : the corrections to be applied to the observed altitude are as follow :

First, The index error as before directed.

Secondly, The dip to be subtracted in the fore observation, and to be added in the back observation.

Thirdly, Semi-diameter to be found in the nautical ephemeris for every noon and midnight at Greenwich ; if very great accuracy is required this semi-diameter must be corrected for the intermediate time : which being added to, or subtracted from, the observed altitude, will give the apparent altitude of her centre.

Fourthly, Parallax and refraction. The moon's horizontal parallax for every noon and midnight at Greenwich, is to be found in the nautical ephemeris. This must be corrected for the intermediate time ; then take the proportional logarithm of the moon's horizontal parallax out of the nautical almanac, increase its index by 10, and subtract the log. co-sine of the moon's apparent altitude from the sun ; the remainder will be the proportional logarithm of her parallax in altitude ; from which take the moon's refraction, (table 5) and the remainder will be the correction of the moon's altitude, which being added to her apparent altitude, will give the true altitude of her centre.

*To take the Altitude of a Star by the Fore Observation.*

Set the index at O, and holding the plane of the quadrant vertical, direct the sight to the star, and at the same time look for the

reflected image of the star in the silvered part of the horizon glass; move the index a little, which will separate the reflected image from the direct image, the former will be easily distinguished from the latter by its motion, when you stir the index; continue to advance the index, and at the same time follow the reflected image of the star with your eye, directing the sight lower and lower, and changing the position of the quadrant or octant, as the image of the star descends, till you have brought it down to the horizon, the index will then shew the observed altitude of the star. The corrections to be applied to the observed altitude of the star are: First, the Index Error; secondly, the Dip, these two give the apparent altitude; thirdly, the Refraction, which gives the true altitude; the fixed stars have neither semi-diameter nor parallax worth notice.

In taking the altitude of a star, or the moon, by night, always get as near the water as possible, in easy weather a grating may be slung over the ship's side, and an observer sit upon it to take the altitudes; the same may be done to take the altitude of the sun in an hazy horizon; for the nearer the eye is to the surface of the water, the nearer the true horizon will be to the eye.

*Advice to Seamen in the Choice of their Quadrants or Sextants.*

The joints of the frame must be close without the least opening or looseness, and the ivory on the arch and nonius inlaid and fixed, so as not to rise at the ends, nor above the plane of the instrument; all the divisions on the arch and nonius must be exceeding fine and straight, so that when the index or nonius is set to any division on the arch, the divisions on the line that coincides may appear distinct, for only the first and last line on the nonius will coincide with the other lines upon the arch, if the quadrant is well divided; likewise try in different parts of the arch, if the nonius, or index plate, cuts regularly in order with those on the arch, if they do not, the divisions are bad, and the quadrant ought to be rejected.

Again, look into the great speculum or index-glass slant-ways, holding it about ten or twelve inches from the eye, and observe the image of some distant object; if the image appears clear and distinct in every part of the glass, the speculum is good; but if it appears notched, or drawn with small lines, the glass is veiny, and must be rejected; if more images than one of the same object are seen, it shews that the two surfaces are not ground parallel; the other speculum may be examined in the same manner.

Observe the sun or a candle through the dark glasses severally, holding the glass about eight or ten inches from the eye; if they are veiny the object will appear notched at the edges, but if clear and well defined, the glasses are good.

Most

Most people prefer black ebony, on account of its weight; but I have found by experience, that good mahogany takes the glue, and stands the heat better.

Quadrants, like watches, may appear well to the eye, and yet be good for little; it is therefore much better to give two guineas and an half, or three guineas, for a good one, that will last a man for life, than purchase those wretched instruments made up at a low price, which cannot be depended on.

### *Of the Dip and Refraction.*

The rays of light in passing through the atmosphere are bent out of their straight course into a curve line; and hence it happens that all the heavenly bodies, except when they are in the zenith, appear higher than they ought to do, and so much the more the nearer they are to the horizon. This apparent elevation of the heavenly bodies above their true height is called the refraction of objects; and the quantity or effect of it, according to the different altitudes of objects, has been carefully observed by eminent astronomers, and must always be subtracted from the apparent altitude, but added to the apparent zenith distance of an object with whatever instrument the observation is made, in order to obtain its true altitude or zenith distance.

That the corrections of observed altitudes of objects, both on account of the dip of the horizon and the refraction of their light, may appear at one view, they are both exhibited together in the tables.

*To work an Observation, or to find the Latitude of a Place, by the Tables, of the Sun or Star's Declination and the Zenith Distance.*

The latitude of any place is its distance from the equator, either north or south, counted in degrees, &c. upon an arch of the meridian, contained between the zenith, or that point directly over your head and the equator. It can never exceed 90 degrees, and is found by taking the altitude or height of the sun or star above the horizon of the sea with a quadrant, when on the meridian or due north or south of the place of observation.

This meridian altitude, corrected for dip of the horizon, and refraction, and 16 minutes the sun's semi-diameter added thereto, gives the altitude of his centre, which being subtracted from  $90^{\circ}$ , gives the zenith distance or the number of degrees, &c. the centre of the object is from the point over your head; with which, and knowing how far the object is to the north or south of the equator, which is called declination, the latitude is found by the meridian altitude of any celestial object as follows:

First, If the sun or star be south when observed, call the zenith distance south; but if north, call it north.

U 2

Then



Then if the zenith distance and declination be of contrary names; that is, if the sun or star comes to the meridian in the north, and hath south declination, or to the south, and hath north declination, the zenith distance, added to the declination, gives the latitude of the place of observation; and of the same name the declination is of, whether north or south.

Secondly, When the zenith distance and declination are of the same name; that is, when the sun or star comes to the meridian in the north, and hath north declination; or to the south and hath south declination, subtract the lesser from the greater, and the remainder is the latitude; and to know whether it is north or south, to observe this general rule:

When the declination is greater than the zenith distance, the latitude is of the same name with declination; but if less, of a contrary name.

NOTE. First, When the sun or star is on the equator, or hath no declination, the zenith distance is the latitude of the place, and of a contrary name to the zenith distance.

Secondly, When the sun or star is in the zenith, the declination is the latitude, and of the same name as the declination is of. For it is evident, that as they are equally distant from the equator, and on the same side of it; consequently if the declination be north, the latitude will be also north, and if south, south.

### EXAMPLE I. and II.

Being at sea May 27, 1796, the sun's meridian alt. was found to be  $57^{\circ} 35'$ , and it was south of me, what latitude was I in?

|                                     |                  |    |
|-------------------------------------|------------------|----|
|                                     | $90^{\circ} 00'$ |    |
| Meridian altitude                   | $57 \quad 35$    |    |
| Zenith distance =                   | $32 \quad 25$    | S. |
| Sun's decl. in table for May 27, is | $21 \quad 28$    | N. |
| Latitude in =                       | $53 \quad 53$    | N. |

### EXAMPLE III.

Being at sea January 14, 1796, the sun's mer. altitude was found  $72^{\circ} 17'$  south, what was the latitude of the place of observation?

|                         |                  |    |
|-------------------------|------------------|----|
|                         | $90^{\circ} 00'$ |    |
| Meridian altitude       | $72 \quad 17$    |    |
| Zenith distance =       | $17 \quad 43$    | S. |
| Sun's decl. Jan. 14, is | $21 \quad 18$    | S. |
| Latitude in =           | $3 \quad 35$     | S. |

In this case, it is plain the observer was between the sun and the equator.

Being at sea 24th July, 1796, meridian altitude of the sun was  $27^{\circ} 13'$  being the north of me, required the latitude in?

|                                  |                  |    |
|----------------------------------|------------------|----|
|                                  | $90^{\circ} 00'$ |    |
| Meridian altitude =              | $27 \quad 13$    | N. |
| Zenith distance =                | $62 \quad 47$    | N. |
| Sun's decl. in table for July 24 | $19 \quad 42$    | N. |
| Latitude in =                    | $43 \quad 05$    | S. |

### EXAMPLE IV.

Being at sea the 4th of May, 1796, I observed the bright star Fomalhaut  $27^{\circ} 21'$  above the horizon of the sea, and it was south of me, required the latitude in?

|                   |                  |    |
|-------------------|------------------|----|
|                   | $90^{\circ} 00'$ |    |
| Meridian altitude | $27 \quad 21$    |    |
| Zenith distance   | $62 \quad 39$    | S. |
| Fomalhaut's decl. | $30 \quad 42$    | S. |
| Latitude in =     | $31 \quad 57$    | N. |

NOTE. The declination here is fitted to the year 1796.

The foregoing rules are for observing by the sun or stars when they are at the greatest altitudes, or upon the meridian above the pole, but as in some parts of the earth, the sun does not set for several days, and some stars never set, in that case they may be observed upon the meridian twice in 24 hours; that is, once at their greatest height as before, and again when they are at their lowest or upon the meridian below the pole, to work which observations, take the following

RULE. Add the complement of the declination to the meridian altitude, the sum is the latitude of the same name with the declination.

## EXAMPLE V.

At sea I took the altitude of the north pole star, when on the meridian below the pole, and found it  $46^{\circ} 21'$ ; required the latitude?

|                    |                     |
|--------------------|---------------------|
| Meridian altitude  | $46^{\circ} 21' N.$ |
| Compl. declination | $1 \quad 47' N.$    |

$$\text{The latitude in} = 48 \quad 8 \text{ N.}$$

In the following examples the corrections for dip and refraction are introduced:

NOTE. As all the calculations are for 1796, those that teach by this book, will do well to furnish themselves in time with the above almanac.

## EXAMPLE VI.

By a fore observation, the alt. of the sun's lower limb was found by Hadley's Quadrant to be  $40^{\circ} 20' S.$  when his declination was  $9^{\circ} 56' N.$  the eye being 30 feet above the horizon; required the latitude of the place?

Obs. alt. sun's lower edge  $40^{\circ} 20'$   
Semi-diameter to be added 16

App. alt. sun's centre  $40 \quad 36$   
Dip of ho. to be subtracted 05

App. alt. corrected by dip  $40 \quad 31$   
Refraction to be subtracted 01

True alt. of sun's centre  $40 \quad 30$

Zenith distance  $49 \quad 30 S.$   
Declination  $9 \quad 56 N.$

Latitude  $59 \quad 26 N.$

## EXAMPLE VIII.

Suppose the eye of an observer at 35 feet above the water should with Hadley's Quadrant, by a fore observation, find the alt. of Sirius  $53^{\circ} 35' S.$  when it passed the meridian, having before hand set his watch, and found the time of Sirius passage; required the latitude of the place of observation?

Obs. alt. of Sirius  $53^{\circ} 35' 0''$   
Dip. of hor. to be subtr. 05 39

App. alt. above hor.  $53 \quad 29 \quad 21$   
Refraction to be subtr. 42

True alt. of Sirius  $53 \quad 28 \quad 39$

True zenith distance  $36 \quad 31 \quad 21 S.$   
Sirius's declination  $16 \quad 26 \quad 47 S.$

Latitude  $20 \quad 04 \quad 34 N.$

## EXAMPLE

## EXAMPLE VII.

By a back observation with Hadley's Quadrant, the app. alt. of the sun's lower edge was  $25^{\circ} 12' S.$  when his declination was  $21^{\circ} 14' S.$  and the eye 40 feet above the horizon, in what latitude was the observation made?

Obs. alt. sun's lower edge  $25^{\circ} 12' S.$   
Semi-diam. to be subtracted 16

App. alt. sun's centre  $24 \ 56$   
Dip of hor. to be added 06

App. alt. correct by the dip  $25 \ 02$   
Refraction to be subtracted 02

True alt. sun's centre  $25 \ 00$

True zenith distance  $65 \ 00 \ S.$

Declination  $21 \ 14 \ S.$

Latitude  $43 \ 46 \ N.$

App. alt. sun's lower limb  $8^{\circ} \ 15' \ S.$   
Semi-diameter added 16

App. alt. sun's centre  $8 \ 31$   
Dip horizon subtracted 05

Sun's alt. corrected by dip  $8 \ 26$   
Refraction to be subtracted 06

True alt. of sun's centre  $8 \ 20 \ S.$   
Complement sun's declination  $66 \ 44 \ N.$

Latitude in  $75 \ 04 \ N.$

## EXAMPLE IX.

Suppose on the 12th June, 1796, an observer in an high northern latitude and  $65^{\circ}$  west of London, his eye being 28 feet high, observed the alt. of the sun's lower limb on the meridian below the pole to be  $8^{\circ} \ 15' S.$  by a fore observation with Hadley's Quadrant; required the latitude?

The sun being observed below the pole, it must have been at 12 hours past noon at the place of observation, and that place being  $65^{\circ} W.$  of London = 4 hours  $20'$  later than at London, therefore it must have been 16h.  $20'$  past noon at London.

\* June 12, 1796, the sun's declination  $23^{\circ} \ 13' \ 46''$  the daily variation is  $3' \ 12''$ : and as 24h.  $3' \ 12''$ : :: 16h.  $20': 2' \ 11''$ , which added to  $23^{\circ} \ 13' \ 46''$  (because the declination is increasing) gives  $23^{\circ} \ 16'$ , the sun's declination at the time and place of observation nearly.

## OF THE VARIATION OF THE COMPASS.

THE variation of the compass is an arch of the horizon contained between the meridian of the place and the magnetic meridian, and is either east or west; or it is the number of degrees, &c. the needle's point stands from the true north or south points

\* See Nautical Almanac for 1796.



of the horizon, reckoned to the eastward or westward, and is readily found either from the sun's amplitude or azimuth.

*To find the true Amplitude.*

The sun's true amplitude is an arch of the horizon comprehended between the true east or west points thereof, and the centre of the sun at its rising or setting; or it is the number of degrees, &c. the sun rises or sets to the northward or southward of the east or west points of the horizon.

The sun's magnetic amplitude is the number of degrees, &c. the centre is northward or southward of the east or west points of the compass at his rising or setting, and is found with an azimuth compass in the following manner:

Having placed the azimuth compass in a convenient part of the ship, look directly through the sight vanes at the sun's centre; and when the sun's lower edge just touches the horizon, stop the card, by a stop which is placed on the compass for that purpose; then the quantity of degrees and minutes contained between the east or west, and the north and south points of the compass, will be the magnetic amplitude.

The true amplitude is found either by inspection in the tables of the sun's amplitude, or by calculation as follows:

**RULE.** As the sine complement of the latitude

Is to radius,

So is the sine of the sun or star's declination

To the sine of the true amplitude;

Which is always of the same name with the declination, whether north or south.

Or, to the secant of the latitude, (rejecting the index) add the log. sine of the sun's declination, the sum will be the log. sine of the true amplitude.

**NOTE.** The arithmetical complement of the co-sine of any arch is always equal to the secant of that arch, throwing away radius, or neglecting one, which stands the first figure in the secant's index; likewise the arithmetical complement of the sine of any arch, is the co-secant of that arch less radius, or the first figure of its index: Wherefore, the arithmetical complement of the sine or co-sine of any arch is found in the table of secants by inspection.

**E X A M P L E I.**

On the 20th of October, 1796, in latitude  $51^{\circ} 32' N.$ ; I demand the true amplitude?

|                                         |          |                                     |         |
|-----------------------------------------|----------|-------------------------------------|---------|
| As sine com. lat. $51^{\circ} 32'$      | 9,79383  | Or thus:                            |         |
| Is to radius                            | 10,00000 | Lat. $51^{\circ} 32' N.$ secant     | 0,20617 |
| So is si. f's. dec. $10^{\circ} 43' S.$ | 9,26940  | Decl. $10^{\circ} 43' S.$ log. sine | 9,26940 |
|                                         |          | True amp. $17^{\circ} 24' S.$ =     | 9,47557 |

**EXAMPLE**

## EXAMPLE II.

In latitude  $38^{\circ} 25' N.$  what is the sun's true amplitude when the declination is  $18^{\circ} 59' N.$ ?

|                                     |          |                                        |         |
|-------------------------------------|----------|----------------------------------------|---------|
| As fine com. lat. $38^{\circ} 25'$  | 9,89405  | Or thus :                              |         |
| Is to radius                        | 10,00000 | Lat. $38^{\circ} 25' N.$ secant        | 0,10598 |
| So is sun's decl. $18,59$           | 9,51227  | Decl. $18^{\circ} 59' N.$ log. fine    | 9,51227 |
| <hr/>                               |          | <hr/>                                  |         |
| To sun's true amp. $24^{\circ} 32'$ | 9,61822  | Log. fine $24^{\circ} 32'$ true am. N. | 9,61822 |

*To find the true Amplitude by the Table of Amplitudes.*

Look for the given declination at the top of the table, and the latitude in the first column on the left hand, in the common angle of meeting, will be the degrees and minutes of the amplitude required.

## EXAMPLE I.

In latitude  $40^{\circ} N.$  when the declination was  $17^{\circ} N.$  required the sun's true amplitude at rising?

Under declination  $17^{\circ}$ , and right against the latitude  $40^{\circ}$ , stands  $22^{\circ} 26'$  the true amplitude, and is to be counted from the east towards the north, because it is at the sun's rising, and the declination is north; that is, E.  $22^{\circ} 26' N.$

But when the latitude is given in degrees, and the declination in degrees and minutes, find the declin. at the top as before, and the nearest degrees to the given latitude in the left hand column, against which, and under the given declin. stands the true amplitude; or, if the minutes of the declination be near 30, or half a degree, find the amplitude for the given degrees of declination, and the amplitude for one degree above it, and these two amplitudes together, half their sum will be the true amplitude, sufficiently exact for practice at sea.

## EXAMPLE II.

Suppose I would know the sun's true amplitude at his setting latitude  $57^{\circ}$ , his declination being  $11^{\circ} 33' S.$

Find the ampl. as before for the  $\{ 11^{\circ} \}$  which will be  $\{ 20^{\circ} 29'$

Lat.  $57^{\circ}$ , and the declinations  $\{ 12 \}$  which will be  $\{ 22^{\circ} 25'$

Their sum 42 54

Half the sum 21 27

the true amplitude; that is, W.  $21^{\circ} 27' S.$  because at sun setting and the declination south. In like manner, if the declination in degrees, and the latitude in degrees and minutes, as in

EXAMPLE

## EXAMPLE III.

Suppose it were required to find the sun's true amplitude at setting in latitude  $49^{\circ} 27'$ , when his declination was  $21^{\circ}$  N.

Now 27 minutes being nearly half a degree, therefore,

For lat.  $49^{\circ}$  } and declination  $21^{\circ}$  }  $33^{\circ} 6'$   
 For lat.  $50$  } the amplitudes are }  $33 \quad 52$

Sum  $66 \quad 58$

Half the sum is  $33 \quad 29$ , the true amplitude required; that is, W.  $33^{\circ} 29'$  N. because the sun was setting, and the declination N.

When the latitude and declination are both given in degrees and minutes, take the nearest degrees to both, unless they are near 30 minutes, as observed before, and find the amplitude as in Example I.

## EXAMPLE IV.

Suppose it were required to find the sun's true amplitude at setting, in latitude  $49^{\circ} 18'$ , his declination being  $19^{\circ} 41'$  N.

Now as the latitude is nearest to  $49^{\circ}$ , and the declination nearest to  $20^{\circ}$ , therefore against latitude  $49^{\circ}$  and under declination  $20^{\circ}$ , stands  $31^{\circ} 25'$  N. the true amplitude; that is, W.  $31^{\circ} 25'$  N. the declination being north, and at the sun's setting.

*To find the true Azimuth.*

The true azimuth is an arch of the horizon, contained between the meridian of the place and the azimuth circle, passing through the centre of the sun or star at the time of observation; or it is the true distance of the sun or star from the true north and south points of the compass.

The magnetic azimuth is an arch of the horizon contained between the magnetic meridian and the azimuth circle, passing through the centre of the sun or star when observed; or it is the apparent distance of the sun or star from the north or south points of the compass, either in the forenoon or in the afternoon, when they are  $5^{\circ}, 10^{\circ}, 15^{\circ}$ , &c. above the horizon; and the less the altitude is, the more exact you may perform the observation.

The magnetic azimuth is found by the compass in the following manner:

Place the compass in a convenient part of the ship; then move it so that the sights may be directed to the sun's centre; and the shadow of the string will fall directly on the line marked on the plane which join the sights; then the degree, &c. in the arch intercepted between the end of the index, and north point of the card, will give the magnetic azimuth required. If the sun does not shine strong enough to give a strong shadow,



look through one of the sights, and move the compass till one of the strings cuts the sun's centre, and then the intercepted arch, as before, shews the sun's azimuth, and the like of the star's.

When there is a rough sea, the observation is best made by two persons, and if the card vibrates much take the middle degree between the limits which the vibration reaches.

When the azimuth is observed, the altitude of the object must be observed at the same time.

Having the latitude of the place of observation, and the sun or star's declination with the altitude at the time of observation, the true azimuth is found as follows:

To find the true azimuth, observe these general rules:

### R U L E.

Add the complement of the latitude,  
the complement of the altitude,  
and the sun or star's polar distance into one sum:

From half this sum, subtract the polar distance,  
and note the half-sum and the remainder.

Then add together

The arithmetical comp. of the log. co-sine of the latitude,

The arithmetical comp. of the log. co-sine of the altitude,

The log. sine of the half-sum,

And the log. sine of the remainder into one sum.

Half the sum of these four logarithms, will give the log. co-sine of half the true azimuth, which being doubled, gives the true azimuth, reckoned from the north in north latitude, and from the south in south latitude.

Or thus:

Add together

The log. co-secant of the comp. latitude, } Rejecting the indexes  
The log. co-secant of the comp. altitude, }

The log. sine of the half-sum,

And the log. sine of the remainder, into one sum;

Half the sum of these four logarithms, will be the log. co-sine of the half of the true azimuth.

N. B. The polar distance of the sun or star, is their distance from the nearest, or elevated pole, and if the latitude of the place, and the declination of the sun or star, be both north, or both south, then the complement of the declination is the polar distance; but if the latitude and declination be one north, and the other south, the declination added to  $90^\circ$  gives the polar distance.

EXAMPLE

## EXAMPLE I.

In latitude  $51^{\circ} 32' N.$  the sun's altitude was observed to be  $39^{\circ} 28'$ , his declination being then  $16^{\circ} 37' N.$ ; required the true azimuth?

|                   |                                     |              |                                  |              |                                     |
|-------------------|-------------------------------------|--------------|----------------------------------|--------------|-------------------------------------|
| Latitude          | $90^{\circ} 00'$<br><u>51 32 N.</u> | Altitude     | $90^{\circ} 00'$<br><u>39 28</u> | Declination  | $90^{\circ} 00'$<br><u>16 37 N.</u> |
|                   | Co-alt.                             | <u>50 32</u> | Polar dist.                      | <u>73 23</u> |                                     |
| Co-lat.           | 38 28                               | Ar. co-sine  | 0,20617                          |              |                                     |
| Co-alt.           | 50 32                               | Ar. co-sine  | 0,11239                          |              |                                     |
| Polar dist.       | 73 23                               |              |                                  |              |                                     |
| Sum               | <u>162 23</u>                       |              |                                  |              |                                     |
| $\frac{1}{2}$ Sum | 81 11                               | Log. sine    | 9,99484                          |              |                                     |
| Polar dist.       | 73 23                               |              |                                  |              |                                     |
| Remainder         | <u>7 48</u>                         | Log. sine    | 9,13263                          |              |                                     |
|                   |                                     |              | <u>19,44603</u>                  |              |                                     |
|                   |                                     | Log. co-fi.  | $58^{\circ} 06'$ 9,72301         |              |                                     |
|                   |                                     |              | <u>2</u>                         |              |                                     |

True azimuth  $116 12$  from the north.

## EXAMPLE II. Worked by the second method.

In latitude  $42^{\circ} 16' N.$  the sun's altitude was observed to be  $18^{\circ} 40'$  his declination being then  $7^{\circ} 38' S.$ ; required the true azimuth?

|                   |                                     |                               |                                  |              |                                    |
|-------------------|-------------------------------------|-------------------------------|----------------------------------|--------------|------------------------------------|
| Latitude          | $90^{\circ} 00'$<br><u>42 16 N.</u> | Altitude                      | $90^{\circ} 00'$<br><u>18 40</u> | Declination  | $90^{\circ} 00'$<br><u>7 38 S.</u> |
|                   | Co-alt.                             | <u>71 20</u>                  |                                  | <u>97 38</u> |                                    |
| Co-lat.           | 47 44                               | Co-secant                     | 0,13076                          |              |                                    |
| Co-alt.           | 71 20                               | Co-secant                     | 0,02347                          |              |                                    |
| Polar dist.       | 97 38                               |                               |                                  |              |                                    |
| Sum               | <u>216 42</u>                       |                               |                                  |              |                                    |
| $\frac{1}{2}$ Sum | 108 21                              | Log. sine                     | 9,97733                          |              |                                    |
| Polar dist.       | 97 38                               |                               |                                  |              |                                    |
| Remainder         | <u>10 43</u>                        | Log. sine                     | 9,26940                          |              |                                    |
|                   |                                     | Sum                           | <u>19,40096</u>                  |              |                                    |
|                   |                                     | $\frac{1}{2}$ Sum log. co-fi. | $59. 53 =$ 9,70048               |              |                                    |
|                   |                                     |                               | <u>2</u>                         |              |                                    |

True azimuth  $119 46$  from the north.

The following questions are set down for the Learner's exercise:

*Question I.* Being at sea, in latitude  $40^{\circ} 38'$  N. in the afternoon, the sun's altitude was observed to be  $20^{\circ} 46'$ , when his declination was  $17^{\circ} 10'$  S. ; what was the sun's azimuth at that time?

*Answer,*  $137^{\circ} 50'$  from the north.

*Quest. II.* What is the sun's true azimuth in lat.  $26^{\circ} 30'$  N. in the forenoon, when his altitude is  $24^{\circ} 28'$ , and his declination  $22^{\circ} 40'$  north?

*Ans.*  $75^{\circ} 44'$  from the north point of the compass.

*Quest. III.* At the island of St. Helena, the sun's altitude was observed to be  $30^{\circ} 22'$  in the forenoon, his declination being then  $22^{\circ} 58'$  S. ; required the azimuth at that time?

*Ans.*  $72^{\circ} 26'$  from the south, or  $107^{\circ} 34'$  from the north.

*Quest. IV.* What point of the compass does the star Aldebaran bear on, at the Cape of Good Hope, when its altitude is  $22^{\circ} 25'$ ?

*Ans.*  $130^{\circ} 8'$  from the south, or  $49^{\circ} 52'$  from the north.

Having found the sun's true amplitude, or azimuth, by the preceding methods, &c. magnetic amplitude or azimuth by observation, it is evident, that when they agree there is no variation; but when they disagree, then, if the true and observed amplitudes be both of the same name, that is, both north or both south, their difference is the variation; but if the true and observed amplitudes be of different names, that is, one north and the other south, their sum is the variation. Again, if the true and observed azimuths be both on the east, or both on the west side of the meridian, their difference is the variation; but if the true and observed azimuths be one on the east and one on the west side of the meridian, their sum gives the variation; and to know whether the variation is easterly or westerly, observe this general

### R U L E.

Let the observer's face be turned to the sun; then, if the true amplitude or azimuth be to the right hand of the magnetic, or observed, the variation is easterly; but if to the left hand, westerly.

### E X A M P L E I.

Suppose the sun's magnetic amplitude at rising is found to be  $26^{\circ} 12'$  N. but the true is found to be E.  $14^{\circ} 20'$  N. ; required the variation?

From the greater  
Take the lesser

F.  $26^{\circ} 12'$  N.  
E.  $14^{\circ} 20'$  N.

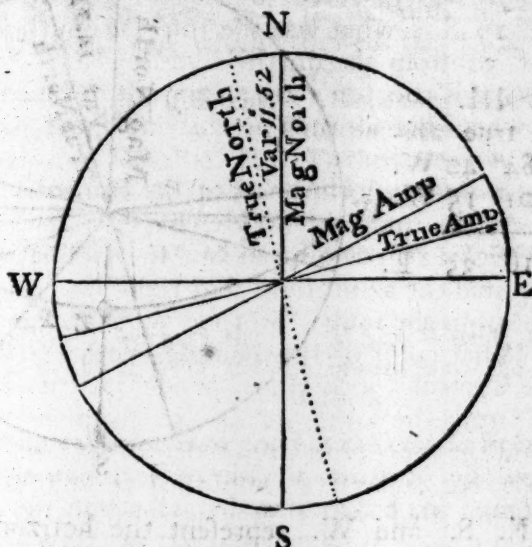
Remains the variation

11 52 E.

Which



Which is easterly, because in this case the true amplitude is to the right of the observed.



With the chord of 60 describe a circle to represent the compass, through which draw the north, south, east and west lines; take the amplitude at rising,  $26^{\circ} 12'$  from the line of chords, and setting it from E. towards N. and likewise the true amplitude  $14^{\circ} 20'$ , and set it from E. towards N. as before, the difference of these two angles, or between the true and magnetic amplitudes, viz.  $11^{\circ} 52'$  is the variation. Now suppose yourself placed at the centre of the horizon, represented by the compass, and looking towards the magnetic amplitude at the sun's rising, it is plain that the true amplitude found by calculation is towards the right hand of the observed, which shews the variation is  $11^{\circ} 52'$  E. and must be allowed to the right hand in all courses steered, before they can be put in the Traverse Table or bearings, taken by the compass.

### EXAMPLE II.

Suppose the sun's true amplitude at setting be W.  $34^{\circ} 26' S.$  and his magnetic amplitude W.  $23^{\circ} 13' S.$  required the variation, since they are both of the same name?

From the greater  
Take the lesser

W.  $34^{\circ} 26' S.$   
W.  $23^{\circ} 13' S.$

Remains the variation

11 13 W.

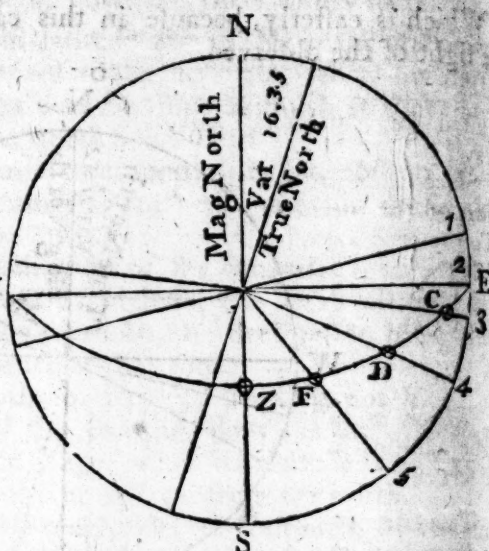
Which is westerly, because the true amplitude is to the left of the observed in this case.

EXAMPLE

## EXAMPLE III.

Suppose the true azimuth  $84^{\circ} 40' W.$   
 The mag. az.  $101^{\circ} 15' W.$

\* Variation  $16^{\circ} 35' E.$



\* Let N. E. S. and W. represent the horizon, C, D, F, an azimuth circle, passing through the sun's centre; now an observer placed at the centre, will see the sun at rising in the line 1, but when he gets a greater altitude, and arrives at E, he will see the sun in the line  $\odot$  2, and as the sun alters its altitude, will be seen in the lines  $\odot$  3,  $\odot$  4,  $\odot$  5, at length will arrive at its meridian Z, S. and the figures 2, 3, 4, 5, will represent the magnetic azimuth; the difference between these and the true azimuth found by calculation is the variation.

## EXAMPLE IV.

Suppose the sun's true amplitude at rising is E.  $13^{\circ} 24' N.$  and his magnetic amplitude E.  $12^{\circ} 32' S.$  required the variation, and which way?

Since the true amplitude and observed have different names,  
 To the true amplitude E.  $13^{\circ} 24' N.$   
 Add the magnetic am. E.  $12^{\circ} 32' S.$

The sum is the variation  $25^{\circ} 56' W.$

Which is westerly, because the true amplitude is to the left of the observed.

## EXAMPLE V.

Suppose the sun's true azimuth in the forenoon is N.  $86^{\circ} 40'$  easterly, but by the compass it is N.  $73^{\circ} 24'$  easterly; required the variation, and which way?

Since the true and observed azimuths are both on the same side of the meridian,

From the greater N.  $86^{\circ} 40' E.$   
 Take the lesser N.  $73^{\circ} 24' E.$

Remainder variation  $13^{\circ} 16' E.$

Which is easterly, because the true azimuth is to the right of the observed.

## EXAMPLE

## EXAMPLE VI.

Suppose the sun's true azimuth is N.  $32^{\circ} 28'$  easterly, and his magnetic azimuth N.  $8^{\circ} 50'$  west; required the variation, and which way?

Since they are on the different sides of the meridian,

To the true azimuth N.  $32^{\circ} 28' E.$   
Add the mag. azim. N.  $8^{\circ} 50' W.$

Sum is the variation  $41^{\circ} 18' E.$

Which is easterly, because the true azimuth is to the right of the observed.

## EXAMPLE VII.

Suppose the sun's true azimuth S.  $17^{\circ} 45'$  E. and the magnetic azimuth S.  $5^{\circ} 48'$  west, required the variation, and which way?

Since they are on different sides of the meridian,

To the true azimuth S.  $17^{\circ} 45' E.$   
Add the observed az. S.  $5^{\circ} 48' W.$

Sum is the variation  $23^{\circ} 33' W.$

Which is west, because the true azimuth is to the left of the observed.

The use of the variation is to correct the course steered by the compass; when the variation is east, it must be allowed to the right hand upon every course steered quite round the compass; but when the variation is west, to the left hand.

NOTE. The variation may be easily found by taking the sun's altitude in the morning, and observing what point of the compass he bears upon; and in the afternoon when the altitude is the same, the middle point will be the true meridian, the difference between which and the north or south points of the compass is the variation. If the altitudes are taken at 5, 6, or 7 o'clock in the morning, you will have the same altitude at 5, 6, or 7 o'clock in the evening, being equally distant from noon.

The variation of the compass was first observed at London, in the year 1580, to be  $11^{\circ} 15'$  easterly; and in the year 1622, it was  $6^{\circ} 0'$  E. still decreasing, and the needle approaching the true meridian, until it coincided with it in the year 1662, since that time the variation still continues at London to increase westerly, at the rate of about 11 or 12 minutes every year; and is at this time about  $23^{\circ} 30'$  westerly, and in the English channel about  $25^{\circ} 30'$  westerly; but how far it will go that way, time and observations will probably be the only means to discover.

The variation at Paris in the year 1640, was  $3^{\circ}$  E. but in the year 1681 it was  $2^{\circ} 21'$  W. and is now about  $22^{\circ} 20'$  westerly, still continuing to go westerly.

In short, from observations made in different parts of the world, it appears, that in different places the variation differs, both as to its quantity and denomination, it being east in one place, and west in another; the true cause and theory of which has not yet been discovered, and therefore in long voyages it is absolutely necessary that the mariner should find the variation of the compass by observation as often as possible.



One **MAGNUS**, a shepherd, first discovered the wonderful power of the loadstone, that gives polarity to the needle, by its sticking to the iron of his sandals; whence the name of **Magnet** was given to the stone, or magnetic needle. **GIO**, of Naples, about 300 years ago, first discovered that a piece of iron rubbed on it, and then suspended, had the property of pointing to the north and south, and thence applied to Navigation. An author of some degree of popularity, who has drawn a variation chart, says, he has found out the theory of the variation of the magnetic needle, without favouring the world with the principles; if his genius has been able to penetrate into the bowels of the earth, to discover this wonderful phenomenon, it is more than **SIR ISAAC NEWTON**'s, or **DR. HALLEY**'s could do; however, his veracity may well be doubted, as **MR. WALES**, who accompanied **Captain COOK** round the world, told me, that his theory did not reach those islands which they discovered.

*How to touch the Compass Needles.*

Having two strong magnetical bars, lay the compass needle as nearly north and south as you can, with the intended north northwards, join the two magnets in a line, considerably above the needle, the north end of each being northward, and bring them down upon the needle, so that the place of junction may be over its centre, then draw them asunder along each half of the needle, and continue their motion till they are eight inches clear of the needle's end; by a circular motion bring them again to the centre and join them as before; repeat this operation six or seven times, taking care not to put the magnets out of their parallelism, and the needle will be sufficiently magnetical.

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THE METHOD OF KEEPING A  
SHIP'S RECKONING OR JOURNAL AT SEA.

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**BY** keeping a Ship's Reckoning or Journal, is meant keeping such an account of the ship's way, that the mariner may be able at any time to ascertain the latitude and longitude the ship is in; it therefore should be the great concern of every person who takes upon them the navigating of ships to remote parts, to be expert therein, as the lives and fortunes of so many men are committed to charge.

When

When a ship is bound from one place to another, which lies so far from her, that she is obliged to go out of sight of land for any considerable time, as from England to Jamaica; at the time of her leaving sight of land, she is said to take her departure, and that part of the land she then leaves, is said to be the place she takes her departure from; such as the Land's-end, Lizard, &c. and at the time of taking such departure, the captain or mate generally takes the bearing and distance of that land (according to his judgment) and sets it down on the log-board, or in the log-book against the time it was taken, thus, Land's-end N. N. E. dist. 7 leagues, or Lizard N. by W. dist. 5 leagues, &c.

In the same manner may the departure from any place be taken, as may be seen in the first day's log of the following journal, where the log-book is marked in columns for hours, knots, fathoms, courses, winds, leeway, transactions; and under it the columns for courses, distances, northings, or southings, eastings, or westings, the latitude by dead reckoning, latitude by observation, meridian distance, difference of longitude, longitude in, and in the last, bearing and distance of the land.

Notice must be taken, that in the column for course, you are always to set down the course you have made by your reckoning for that twenty-four hours; that is, from the noon of the day before to the noon of the day you work on, the sea account being always kept from noon to noon.

Dead reckoning is that account deduced from occurrences which are written on the log-board.

In the columns for distance you are to set down the distance made by your reckoning for that twenty-four hours.

In the columns of nothing and southing, you are to set down the difference of latitude made in that twenty-four hours, marking the column with north, if the difference of latitude be north; and south, if south.

In the column of easting or westing you are to set down the departure made that 24 hours, marking the column with east, if the departure be east, and with west, if westerly.

In the column marked latitude by D. R. you are to set down the latitude you reckon yourself in on that day; and in the column marked lat. by ob. you are to set down the latitude found by observation; also the difference of longitude made in the 24 hours in the column marked diff. long.; the longitude in, in the column marked long. in; and in the last, the bearing and distance from the land.

The variation, if any, must be allowed upon all courses steered, and upon all bearings that are taken by the compass; that is, if it be easterly variation, it must be allowed the right hand, if westerly, to the left of the course or bearing. Supposing your-

self placed in the centre of the compass, and looking directly forward to the point you are to allow the variation upon.

### EXAMPLE.

Suppose I steer S.W. and there is one point westerly variation, then my true course is S.W. by S; or suppose I set a point of land, and find it to bear by the compass E. S. E. and I know there is half a point easterly variation, then the true bearing is S. E. by E.  $\frac{1}{2}$  E.

Leeway must be allowed upon all courses steered, which is the difference between the point which the ship endeavours to sail upon, and the point she really sails upon, and is caused by the force of the wind or surge of the sea, when she is close hauled or plying to windward, which makes her fall off and glide side-ways from the point of the compass she capes at, and must be allowed to be on the right hand of the course steered when the larboard tacks are on board, and to the left hand when the starboard tacks are on board. The allowances that are generally made are as follow :

1st. When a ship is close hauled, if all her sails be set, the water smooth, and a moderate gale of wind, she is then supposed to make little or no leeway.

2dly. The ship being upon a wind, and the small sails in, allow one point for leeway.

3dly. The wind blowing hard, so as to cause one top-sail to be taken in, allow two points for leeway.

4thly. When it blows so hard that both top-sails are taken in, and the sea runs high, allow then three points for leeway.

5thly. The fore-sail being furled, and the ship tries under a main-sail and mizen, allow four points for leeway; for she then makes her way about four points before the beam, as the sea phrase is.

6thly. When the ship tries under the main sail only, she then makes her way about three points before the beam, that is, allow near five points leeway.

7thly. If the ship tries under the mizen only, the way is about two points before the beam; that is, allow six points for her leeway.

8thly. When she lies a hull, that is, with all her sails furled, her way is one point before the beam, and then seven points is her leeway.

9thly. When a ship is lying-to under a main-sail, mizen, &c. then observe how she comes up and falls off, and take the middle between the two points, and from that allow the leeway and variation.

NOTE. In all cases, respect must be had to the smoothness of the water, or to the sea's running high, the mould and trim of the ship, and then the allowances may be ascertained with the greater certainty,



certainty, by setting the ship's wake by a compass placed on each rail of the ship's quarter, which is usually set there for that purpose.

For it is well known, that some ships, with the same quantity of sail, and with the same gale, will make more or less leeway than others; and also the same ship when she is out of her trim, or differently loaded, will make different leeways: for it is observable, that the more water a ship draws, the less leeway she makes; because she then meets with a greater resistance in splitting the water with her side, than otherwise she would.

The leeway may be easily found by the azimuth compass, by turning the instrument about until you see the wake of the ship either over the sights, or parallel to them; then the point of the card, which is cut by the vertical line in the box, which is nearest to you, is the true course; the difference between that and the course given by the compass in the binnacle, is the leeway required, which ought to be accordingly entered upon the log-board.

There is another way of finding the leeway, by fixing a compass cut in lead (or in other metal) on the poop, or some other convenient part of the ship's stern, with the meridian parallel to the ship's side, and in the centre a pin is fixed, to which is fastened a small line of a good length, with a piece of wood at the end of it, that it may be dragged after the ship. The point or degree cut by this line will shew the leeway; if it cuts the meridian, the ship makes no leeway; but if it does not, the difference between the meridian and where it cuts is the leeway.

By some of the above methods, the leeway (if there be any) ought to be carefully observed as often as may be judged necessary; and these observations should be punctually set down by the officer of the respective watch; at least, if no observation be made, he ought to set down the leeway according to his judgment once or twice in the watch, and by this means the course made good may be found to a much greater certainty and exactness than by the common method of allowing for leeway, when the day's account comes to be worked (which is generally once in 24 hours); for an observation must certainly be better than any guess. But if no observation be made, the person who is upon deck, and has the care of the watch, is better able to make proper allowances, while things are fresh in his memory, and while he is an eye-witness of the several accidents that happen; and certainly much more capable than another who was not upon the deck during the whole watch.

I have often admired to see how particularly every thing is stated upon the log-board, excepting the leeway; and yet that (which is one of the most material articles, since the course, according to the compass, must be corrected by it) only allowed for the next day according to every one's fancy, thereby, as it were, keeping as many different journals as there are artists (so called) on

board the ship, and yet not one regular journal properly kept amongst them all, since one of the most material articles is only guessed at.

### EXAMPLE I.

Suppose I steer N. E. by E. with my larboard tacks on board, and make one point leeway, then my course made good is E. N. E.

Leeway and variation, when they are both to be allowed one way, that is, both to the right hand, or both to the left, add them together, and allow their sum the same way they were to be allowed.

But if they are to be allowed, one to the right hand, and the other to the left, subtract the less from the greater, and allow the remainder the same way the greater was to be allowed.

### EXAMPLE II.

Suppose I steer N. N. W. with my starboard tacks on board, and make one point leeway, there being at the time half a point westerly variation; I would know my true course?

|                         |   |                      |
|-------------------------|---|----------------------|
| Leeway to the left hand | 1 | point.               |
| Variation to ditto      |   | $\frac{1}{2}$ point. |

|                                          |   |               |
|------------------------------------------|---|---------------|
| Their sum to be allowed to the left hand | 1 | $\frac{1}{2}$ |
|------------------------------------------|---|---------------|

Whence the true course is N. W. by N.  $\frac{1}{2}$  W.

### EXAMPLE III.

Suppose I steer S. W. by W. with my larboard tacks on board, and make two points and a half leeway, and I have one point and a quarter westerly variation; what is my true course?

|                            |   |                         |
|----------------------------|---|-------------------------|
| Leeway to the right hand   | — | 2 $\frac{1}{2}$ points. |
| Variation to the left hand | — | 1 $\frac{1}{4}$ points. |

|                                          |   |               |
|------------------------------------------|---|---------------|
| The rem. to be allowed to the right hand | 1 | $\frac{3}{4}$ |
|------------------------------------------|---|---------------|

Whence the true course is W. S. W.  $\frac{3}{4}$  westerly.

### EXAMPLE IV.

Suppose a ship lying-to under a main-fail, with her starboard tacks on board, comes up E. by S. and falls off to N. E. by E. there being one point westerly variation, and she makes 5 points leeway; what course does she make good?

The middle between E. by S. and N. E. by E. is E. by N.; for which, allowing 6 points to the left hand, the true course will be N. by E.

It is plain, by the preceding examples, that if the leeway is made towards

towards the meridian, it is taken from the course steered; but when it is made from the meridian, it must add to the course steered, to find the true course. The same may be observed of the sum or difference of the leeway and variation, as may be seen by the following table, which is here set down to exercise the young Navigator in the foregoing rules.

The T A B L E.

| Courses steered.                                                                    | Winds.                                                                                                     | Lee-way.                                                                                                                 | Variation.                                                      | Courses corrected.                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| N. W. $\frac{1}{2}$ W.<br>W.<br>W. S. W.<br>W.<br>W. by N.<br>S. W.                 | N. N. E.<br>N. N. W.<br>S.<br>S. S. W.<br>N. by W.<br>W. N. W.                                             | $\frac{1}{2}$<br>$\frac{3}{4}$<br>1<br>$\frac{3}{4}$<br>$1\frac{1}{4}$<br>$1\frac{1}{2}$                                 | $\frac{1}{4}$ W.                                                | N. $5\frac{1}{4}$ W.<br>S. $6\frac{1}{4}$ W.<br>S. $6\frac{1}{2}$ W.<br>W.<br>S. 7 W.<br>S. $1\frac{1}{4}$ W.                                                                                                                                    |
| S.<br>S. S. W.<br>S. W.<br>W.<br>W. by N.<br>S.<br>E. by S.<br>E. N. E.<br>E.<br>E. | W. S. W.<br>W.<br>N. W. by W.<br>S. S. W.<br>N. by W.<br>E. S. E.<br>S. $\frac{1}{2}$ E.<br>N.<br>N.<br>S. | $\frac{3}{4}$<br>1<br>$\frac{1}{2}$<br>$1\frac{1}{4}$<br>1<br>2<br>$\frac{3}{4}$<br>$1\frac{1}{4}$<br>$\frac{3}{4}$<br>0 | $1\frac{1}{4}$ W.                                               | S. S. E.<br>S. $\frac{1}{2}$ E.<br>S. S. W. $\frac{1}{2}$ W.<br>W. by N. $\frac{1}{2}$ W.<br>W. S. W. $\frac{3}{4}$ W.<br>S. $\frac{3}{4}$ W.<br>E. by N.<br>E. N. E. $\frac{1}{2}$ E.<br>E. by N. $\frac{1}{2}$ E.<br>E. N. E. $\frac{3}{4}$ E. |
| S.<br>E. S. E.<br>W. S. W.<br>W. by N.<br>N. W.                                     | E. S. E.<br>N. E.<br>S.<br>S. W. by S.<br>W. S. W.                                                         | $\frac{1}{2}$<br>$\frac{1}{2}$<br>$\frac{3}{4}$<br>1<br>1                                                                | $1\frac{1}{4}$ W.                                               | S. by E. $\frac{1}{4}$ E.<br>E. by S. $\frac{1}{4}$ E.<br>S. W. by W.<br>W. $\frac{1}{4}$ N.<br>N. W. $\frac{3}{4}$ W.                                                                                                                           |
| S.<br>N. by E.<br>N. W. by N.<br>N. W. by W.<br>W. by S.                            | W. S. W.<br>N. W. by W.<br>W. by S.<br>N. by E.<br>N. W. by N.                                             | 1<br>$\frac{3}{4}$<br>$1\frac{1}{4}$<br>$1\frac{1}{2}$<br>$1\frac{3}{4}$                                                 | $0\frac{3}{4}$ E.<br>1<br>1<br>$1\frac{1}{4}$<br>$2\frac{1}{4}$ | S. $\frac{1}{2}$ E.<br>N. N. E. $\frac{3}{4}$ E.<br>N. $\frac{3}{4}$ W.<br>N. W. by W. $\frac{1}{4}$ W.<br>W. $\frac{1}{2}$ S.                                                                                                                   |

NOTE. In sailing in the channel, or along a coast in a tide or current, particular care must be taken to take its setting for a course, and its drift for a distance, which must be entered among the courses and distances in the table of that day's reckoning. And



And where the setting of the tide and drift are not known, you must attain the point it must set upon, both of the flood and ebb, from the chart of the coast you are sailing along, by the times of high water at different places on the coast, and by the principles of fluids acting against such rocks, shoals, sand banks, &c. By a strict regard to these, both the drift and setting of the tides may be pretty nearly ascertained and allowed for.

Currents, the way they set you, and the distance you suppose you are driven by them, is to be set in the traverse table for the day, as any other course and distance.

### EXAMPLE V.

Suppose I try the current, and find it to set W. by N. per compass one mile per hour, the variation being one point easterly; then if I sail in that current 24 hours, I set down in the table as a course, W. N. W. distance 24 miles.

Heave of the sea is to be accounted for in the same manner as currents: as, suppose there is a great sea heaving towards the S. W. by my compass, there being half a point westerly variation, I then set down in my traverse table S. W. by S. half westerly, with so much distance as I judge the sea has heaved the ship.

At leaving the land, the opposite point of the bearing, with the variation allowed upon it, and the distance you judge yourself from it, must be set down in the traverse table as a course and distance.

### EXAMPLE VI.

Suppose having one and a quarter point westerly variation, the Start bearing by my compass N. N. E. distant four leagues; the opposite point to N. N. E. is S. S. W. which, with the variation, makes S.  $\frac{3}{4}$  westerly, for the course to be set in the traverse table distant 12 miles.

When you make the land your bearing, itself (with the variation allowed upon it, and the distance you judge yourself from it, is to be set down in the traverse table, as a course and distance. This needs no example.

The courses marked on the log-board are the courses steered by the compass. In order to obtain the true course, it is necessary to allow both for the variation of the compass, and for the leeway upon each course on the log-board, as has been shewn, before they are put into the traverse table.

Every day, at noon, the log-board is to be transcribed into the log-book which is ruled exactly like the log-board.

Mariners reckon by the civil account of time used on shore, but they keep the reckoning for the ship's place, by beginning at noon

noon, and counting from thence 24 hours to the next noon. From noon to midnight they mark with P. M. signifying after mid-day ; and the second twelve hours with A. M. signifying after midnight ; ending their day's work at the noon of the civil day. Hence their ship's account is twelve hours earlier than their shore account of time. And as the sun's declination used for finally determining the ship's place at the end of the sea day is calculated for the noon of the common day at London or Greenwich, therefore the declination for the noon of the civil day, must be taken for determining the latitude, &c. at finishing their day's account. Thus, a day's work marked Tuesday, May 6th, began on Monday at noon, and ends on Tuesday noon, so that the sun's declination for the 6th of May is used for the noon of Tuesday, and fitted to the meridian of the ship, according as she is E. or W. of London.

There are various methods of keeping a sea journal, according to the sentiments of various persons with regard to what deserves being recorded : some approve of a journal including the log-book, each day's work at some length, and such occurrences as seem of most importance ; while others prefer a short abstract of this long journal, containing little more than the course run, the latitude and longitude in, and sometimes the bearing and distance of the intended port for each day.

In the following journal the long form is used as representing more fully each day's work, and the necessary corrections ; and an abstract of this may be drawn out in the shortest form that seems consistent with distinctness. The Learner ought to be thoroughly acquainted with the long form, and when he does that, he may either continue it, or take the shortest form ; or retrenching from the first, and adding to the second what particulars he thinks proper, and thereby make out a form adapted to his own particular taste.

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## RULES for correcting the DEAD RECKONING by an' Observation.

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NOTWITHSTANDING the rules already laid down for keeping a ship's way at sea, yet by reason of the several accidents that may attend a ship in one day's run, such as swelling seas, different rates of sailing between the times of heaving the log, want of  
care

care at the helm in letting the ship fall off or come to, accidental currents, sudden squalls, when no account can be kept, &c. the latitude by account and latitude by observation may very often differ, then it is necessary that proper corrections be made in the difference of longitude.

When you have made all proper allowances you can, such as for leeway, variation, currents, &c. and still find that your latitude by account will not agree with your latitude by observation, then you must correct as follows:

First, Consider whether you have made proper allowances for currents, heave of the sea, if the course at the helm has been carefully attended to, if the log-line and half-minute glass be just, and the log properly hove, or any sudden squalls, or proper allowances made for the leeway, &c. which of these you conjecture your error is in; make what allowances you think meet to your difference of latitude and departure by dead reckoning, and see if that will reform your latitude by account, so as to make it agree with your latitude by observation; if it does, you have guessed right (for you must always keep to the latitude by observation, it being the only thing to be depended on); but if it will not agree with the observed latitude, it is to be supposed that there are mistakes in your conjecture, or some other cause which produces the error in the reckoning, and stands in need of being corrected. In this case, you are first to examine your log-line and half-minute glass, and if there be an error in them, allow for it, as in the following example.

#### EXAMPLE I.

Yesterday at noon, we were in latitude  $48^{\circ} 20' N.$  and till this day at noon we have sailed S. S. W. 48 miles, S. W. by S. 36 miles, N. E. 24 miles, and find by good observation that we are in latitude  $47^{\circ} 14' N.$

#### TRAVERSE TABLE.

| Courses.    | Dist. | N.   | S.   | E.   | W.   |
|-------------|-------|------|------|------|------|
| S. S. W.    | 48    |      | 44,4 |      | 18,4 |
| S. W. by S. | 36    |      | 29,9 |      |      |
| N. E.       | 24    | 17,0 |      | 17,0 | 20,0 |
|             |       | 17,0 | 74,3 |      | 38,4 |
|             |       |      | 17,0 |      | 17,0 |
|             |       |      | 57,3 |      | 21,4 |



By the Traverse Table it appears, that by account the diff. of lat. is 57,3 S. and the departure 21,4 W.

Now the lat. left was ——— 48° 20' N.

Diff. of lat. by account ——— 57 3 S.

Latitude in by account ——— 47 23 N.

Differing 9 miles from the true latitude by observation.

Wherefore I examine the log-line and half minute glass, and find that the former measures 52 feet between knot and knot, and that the latter runs only 27 seconds. Now, as the log-line and half-minute glass are both faulty, I correct my difference of latitude and departure as in Case III. and find my correct difference of latitude 66,2 S. and my departure 24,7 W.

Now from latitude left ——— 48° 20' N.

Take diff. corrected for error in dist. ——— 1 6 S.

Lat. in, corrected for error in dist. ——— 47 14 N.

Agreeing exactly with my latitude by observation: I therefore conclude my reckoning sufficiently correct. Then, with the difference of latitude 66,2, and departure 24,7, together with yesterday's latitude, I find the difference of longitude either by Middle Latitude or Mercator's Sailing.

In the last example 57,3, and 21,4, multiplied severally by 156, thrice the measured length of a knot, and divide the two products by 135, five times the measured time of the glass, will give the difference of latitude 66,2, and departure 24,7, which is the same thing as if every course had been corrected separately.

## E X A M P L E II.

Yesterday at noon, we were in lat. 36° 15' N. and have sailed these 24 hours S. E.  $\frac{1}{2}$  E. 55 miles, N. E. by N. 20 miles, W. S. W. 70 miles, S. by W.  $\frac{1}{2}$  W. 20 miles, and by observation this day at noon we are in lat. 34° 56' N.

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The

## The TRAVERSE TABLE.

| Courses.                  | Dist. | N.   | S.   | E.   | W.   |
|---------------------------|-------|------|------|------|------|
| S. E. $\frac{1}{2}$ E.    | 55    |      | 34.9 | 42.5 |      |
| N. E. by N.               | 20    | 16.6 |      | 11.1 |      |
| W. S. W.                  | 70    |      | 26.8 |      | 64.7 |
| S. by W. $\frac{1}{2}$ W. | 20    |      | 19.1 |      | 5.8  |
|                           |       | 16.6 | 80.8 | 53.6 | 70.5 |
|                           |       |      | 16.6 |      | 53.6 |
|                           |       |      | 64.2 |      | 16.9 |

By the Traverse Table it appears, that by account the diff. of lat. is 64.2 S, and the departure 16.9 W.

|                                   |   |            |
|-----------------------------------|---|------------|
| Latitude failed from              | — | 36° 15' N. |
| Difference of latitude by account |   | 1 4 S.     |
| Latitude in by account            | — | 35 11 N.   |

Differing 15 miles from the latitude by observation.

I now examine the log-line and half-minute glass, and find them both right. Next I consider whether there be any current, and I think I have reason to suspect one: upon trial I find there is one, setting S. S. W.  $\frac{3}{4}$  W. at the rate of 7 fathoms an hour, and judge I have been in it these 24 hours. Then 7 fathoms (or tenths of a knot) per hour, in 24 hours, makes about 17 miles; and to the dist. 17 miles, and course S. S. W.  $\frac{3}{4}$  W. the diff. of lat. is 14.6 S. and departure 8.7 W.

|                   |            |         |                                     |
|-------------------|------------|---------|-------------------------------------|
|                   | Diff. Lat. | Dep.    |                                     |
| Now by tra. table | 64.2 S.    | 16.9 W. | Latitude failed from 36° 15' N.     |
| And by current    | 14.6 S.    | 8.7 W.  | Diff. of lat. cor. for cur. 1 19 S. |
| Correct for cur.  | 78.8 S.    | 25.6    | Lat. in correct for cur. 34 56 N.   |

Which agreeing with my latitude by observation, I conclude that my reckoning is right; then having the latitude left, and latitude come to, the difference of longitude may be found either by Middle Latitude or Mercator's Sailing as before.

If, after all proper allowances are made for errors in distance, currents, &c. the latitude by account and observed latitude should disagree, then the reckoning must yet be further corrected; and to do which, the following are the common, and seem to be the most rational methods.

CASE

## CASE I.

*If the Course found by Dead Reckoning be less than three Points, or thirty-three Degrees.*

**RULE.** To the difference of latitude and departure by account find a course ; to this course and the difference of latitude by observation, find the difference of longitude, either by Middle Latitude or Mercator's Sailing.

## EXAMPLE.

Yesterday at noon, we were in lat.  $39^{\circ} 18' N.$  by an observation, this noon we are in lat.  $37^{\circ} 48' N.$  and our dead reckoning gives 107 miles of southing, and 64 of westing ; required the true difference of longitude ?

To the difference of latitude 107, and departure 64, I find the course  $2\frac{3}{4}$  points ; then with the meridional difference of latitude between the two observations 115, and the same course, I find the true difference of longitude 69 miles.

## CASE II.

*If the Course found by Dead Reckoning be more than 3 Points, or  $33^{\circ}$ , and less than 5 Points, or  $56^{\circ}$ .*

**RULE.** With the diff. of lat. and dep. by account, find the distance ; with this distance, and diff. of lat. by observation, find another departure. Take half the sum of this dep. and dep. by account, for the true dep. with which and the diff. of lat. by observation, find the diff. of longitude.

## EXAMPLE.

Yesterday at noon, we were in lat.  $52^{\circ} 40' N.$  and are this noon in lat.  $54^{\circ} 22' N.$  having by account made 84 miles of northing and 76 miles of westing ; required the true difference of longitude ?

To the diff. of lat. 84, and dep. 76, the distance is 113 miles, and the course  $42^{\circ}$ .

To dist. 113, and diff. of lat. between the two observations 102, the dep. is 47.7 ; then 76 added to 47.7, is 123.7, half of which is 61.8, the true dep.

To dep. 61.8, and diff. of lat. by observation 102, the course is  $31^{\circ}$ , and with the course  $31^{\circ}$ , and the meridional diff. of lat. between the two observations 171, I find the diff. of long. is 103 miles.



## C A S E III.

*If the Course by Dead Reckoning be more than 5 Points, or  $56^{\circ}$ .*

RULE. With the diff. of lat. and departure by account find the distance; then with this dist. and diff. of lat. by observation find the diff. of long.

## E X A M P L E.

Yesterday at noon we were in lat.  $38^{\circ} 52' N.$  to-day at noon we are in lat.  $40^{\circ} 18' N.$  and by account have made 68 miles of northing, and 112 miles of westing; required the true diff. of longitude?

With the diff. of latitude 68, and departure 112, I find the distance 132 miles, and to distance 132, and difference of latitude by observation 86, the course is  $49^{\circ} 30'$  nearly; with this course, and the meridional difference of latitude between the two observations 111, the difference of longitude is 130 miles.

The reason of the above rule is plain, if we consider, that when a ship sails near the meridian, it will require a sensible error in the course, to make any considerable error in the difference of latitude; which can hardly happen if proper care is taken at the helm; and therefore it is most likely that the error is in the distance run; but when the course is near the middle of the quadrant, or between 3 and 5 points from the meridian, it is then probable the error may be in both the course and distance; and when the course is more than five points from the meridian, it is then most likely the error is in the course, as it will require a great error in the distance to make any considerable one in the difference of latitude.

NOTE. As the true place of a ship depends upon her latitude and longitude being truly ascertained, I have set these down only, the rest being of less consequence to the mariner.

*To correct for several Days.*

By help of the three preceding rules, the longitude may always be corrected for a single day, but if an observation has been wanted for one or more days, then mark the latitude and longitude at last observation, or if this be your first observation since leaving the land, mark the latitude and longitude of the land you left; this is the only latitude and longitude you can call certain; all the following part of the reckoning must undergo a correction, which is made as follows:

Take the northings, southings, eastings, and westings, that you have made since your last observation; or if this be your first observation, then for every day from your leaving the land, minding not to leave out the difference of latitude and departure of the day you correct on, and bring them into the traverse table, by which you will have the whole difference of latitude and departure by account

count since the last observation; and with that same difference of latitude and departure find the course by dead reckoning, then observe which of the foregoing cases that course falls under, and correct by the rule for that case. But when an observation has been wanting for several days, then mark the latitude and longitude you were in at your last observation, of leaving the land as before, and then you may correct with a greater degree of certainty; especially in high latitudes, by the following rules:

## C A S E I.

Reckoning from the last certain latitude and longitude.

When the course given by the meridional difference of latitude and difference of longitude by account, taken as difference of latitude and departure is less than three points, or 33 degrees.

RULE. To the meridional difference of latitude and difference of longitude by account (taken as difference of latitude and departure as shewn in the Mercator's sailing) find a course, with this course and the meridional difference of latitude by observation, find a corresponding departure, which will be the correct difference of longitude.

## E X A M P L E I.

Having sailed three days ago from latitude  $49^{\circ} 57' N.$  and got no observation till this day at noon, and find I am in latitude  $45^{\circ} 23' N.$  and by dead reckoning I am in  $45^{\circ} 12' N.$  having differed my longitude 173 miles; required my difference of longitude?

| M. Parts.                    |               | M. Parts.                  |            |
|------------------------------|---------------|----------------------------|------------|
| Lat. sailed from             | 49 57 N. 3470 | Lat. sailed from           | 49 57 3470 |
| Lat. by Account              | 45 12 N. 3047 | Lat. by obser.             | 45 23 3063 |
| Merid. diff. of lat. by acc. |               | Mer. diff. of lat. by obs. |            |
| 423                          |               | 407                        |            |

To meridian difference of latitude by account 423, and difference of longitude by account 173, the course is  $22^{\circ} 15'$ . Then with the course  $22^{\circ} 15'$ , and meridional difference of latitude between the observations 407, I find the difference of longitude is 167 miles.

## C A S E II.

When the course given by the meridional difference of latitude and difference of longitude by account, (taken as before) is greater than 3 points, and less than 5 points.

RULE. To the meridional difference of latitude and difference of longitude by account, taken as difference of latitude and departure, find a distance; with this distance, and meridional difference of latitude by observation, find a corresponding departure; half the sum of

of this departure, and the difference of longitude by account, is the correct difference of longitude.

## EXAMPLE II.

Three days ago we were in latitude  $45^{\circ} 23' N.$  and have since that time sailed between south and west, have by dead reckoning altered our latitude 94 miles, and our longitude 147 miles; but by an observation this day, we find we are in latitude  $43^{\circ} 34'$ ; required the correct difference of longitude?

| M. Parts.                            |      | M. Parts.                         |      |
|--------------------------------------|------|-----------------------------------|------|
| Lat. sailed from $45^{\circ} 23' N.$ | 3063 | Lat. sailed from $45^{\circ} 23'$ | 3063 |
| Lat. by acc. $43^{\circ} 49' N.$     | 2931 | Lat. by obser. $43^{\circ} 34'$   | 2910 |
| <hr/>                                |      | <hr/>                             |      |
| Mer. diff. of lat. by acc.           | 132  | Mer. diff. by obser.              | 153  |

With the meridian difference of latitude by acc. 132, and difference of longitude by acc. 147, I find the distance 198, and course  $48^{\circ}$ . Then to distance 198, and meridian difference of latitude by observation 153, the dep. is 125; now 125 added to 147 is 272, and half this sum, viz. 136, is the correct diff. of longitude.

## CASE III.

When the course given by the meridian difference of latitude and difference of longitude by account, (taken as before) is more than 5 points or  $56^{\circ}$  degrees.

**RULE.**---To the meridian difference of latitude and difference of longitude by account, taken as difference of latitude and departure, find a distance.

To this distance and meridian difference of latitude by observation, find a corresponding departure, this departure will be the correct difference of longitude.

## EXAMPLE III.

Two days ago I was in latitude  $43^{\circ} 34' N.$  and have since then made by account 50 miles by southing, and 256 miles difference of longitude west, but find by observation that I am in  $42^{\circ} 30' N.$ ; what is my true difference of longitude?

| M. Parts.                            |      | M. Parts.                         |      |
|--------------------------------------|------|-----------------------------------|------|
| Lat. sailed from $43^{\circ} 34' N.$ | 2910 | Lat. sailed from $43^{\circ} 34'$ | 2910 |
| Lat. by account $42^{\circ} 44' N.$  | 2841 | Lat. by obser. $42^{\circ} 30'$   | 2822 |
| <hr/>                                |      | <hr/>                             |      |
| Mer. diff. of lat. by account        | 69   | Mer. diff. of lat. by obser.      | 88   |

Then to meridian difference of latitude by account 69, and diff. of longitude by account 256 (taken as difference of latitude and departure), the distance is 265, and course  $75^{\circ}$  degrees.

And to distance 265, and difference of latitude 88 (the meridian difference of latitude by observation), the departure is 250, which is the correct difference of longitude.

Here



Here we have given at some length the different methods of correcting the dead reckoning by an observation, which are readily done by the table of difference of latitude and departure.

The ship's way is generally greater than the distance given by the log, and it is always safest to have the reckoning a-head of the ship, that the mariner may be looking out for land, and not make it before he is aware of it.

When a great sea sets after the ship, it is common to allow one mile over for every ten given by the log, for the heave of the sea; but if the sea be against or athwart her, her distance must be less than that given by the log.

The error in the ship's reckoning is frequently attributed to unknown currents; for by various causes yet undetermined, there are many counter motions of the water in the open seas, as well as those observed near the shores, where the motions may be tolerably well accounted for. Some of the observed currents in the great seas may perhaps be owing to the tides following the moon, and to the libratory motion the waters may have thereby, and the unsettled setting and drift of these currents may possibly depend on the change in the moon's declination. However, it is well known from observations, that the trade winds occasion a considerable current within their limits, particularly within the Torrid Zone, where the motion is perpetually towards the west, at the rate of 8 or 10 miles a day, but at the extremities of the trade winds, or near the latitudes of  $30^{\circ}$  N. or S. it is likely that the currents are compounded of the said western motion, and of one towards the equator; therefore, all ships sailing within these limits, should allow a course each day for this current.

NOTE. When the difference of latitude by account is less than the difference of latitude by observation, the ship is a-head of the reckoning, but if less, the reckoning is a head of the ship.

When the mariner is dubious of his account of longitude, he generally runs into the latitude of the intended port, and then sails E. or W. if there be sea room, according as it is situated, and keeps a good look-out for the land.

The method I have chosen to introduce the young mariner into the most capital part of navigation is, by shewing him first how to work a few separate day's works independent of each other, and then proceed to a continued journal from London to Madeira and Teneriffe, and back again to England, in which will be inserted most of the occurrences that commonly happen at sea, or in harbour.

I have seen many young navigators who have been taught the principles of navigation on shore, very deficient in keeping a journal at sea; and therefore, must request the Teacher not to omit putting the pupils over the following journal, which will render them ready at working a days work at sea, and confirm in their memory those rules they have been over.

EXAMPLE

## EXAMPLE I.

May 24, 1792; yesterday at noon we were in the latitude of  $46^{\circ} 28' N.$  longitude  $22^{\circ} 18' W.$  and have sailed till this day noon, as by the log-board, the tide having all the time set S. by E.  $2\frac{1}{2}$  miles per hour; required the ship's place and the direct course and distance made good?

| LOG-BOARD. |   |   |          |        |          | TRAVERSE TABLE. |       |                          |              |       |      |
|------------|---|---|----------|--------|----------|-----------------|-------|--------------------------|--------------|-------|------|
| H          | K | F | Courses. | Winds. | Lec-way. | Courses.        | Dist. | N.                       | S.           | E.    | W.   |
| 1          | 6 | 3 | N. N. E. | W.     |          | N. N. E.        | 31    | 28.6                     |              | 11.9  |      |
| 2          | 6 | 2 |          |        |          | E. N. E.        | 35    | 13.4                     |              | 32.3  |      |
| 3          | 6 | 5 |          |        |          | E. by S.        | 36    |                          | 7.0          | 35.3  |      |
| 4          | 6 | 4 |          |        |          | S. S. E.        | 51    |                          | 47.1         | 19.5  |      |
| 5          | 6 | 0 |          |        |          | S. by E.        | 60    |                          | 58.8         | 11.7  |      |
| 6          | 6 | 1 | E. N. E. | N.W.   |          |                 |       |                          |              |       |      |
| 7          | 6 | 6 |          |        |          |                 |       | 42.0                     | 112.9        | 110.7 | Dep. |
| 8          | 5 | 8 |          |        |          |                 |       |                          | 42.0         |       |      |
| 9          | 5 | 6 |          |        |          |                 |       |                          |              |       |      |
| 10         | 5 | 4 |          |        |          |                 |       |                          |              |       |      |
| 11         | 5 | 5 | E. by S. | N.     |          | Lat. left       | —     | $46^{\circ} 28' N.$      | M. Par.      | =     | 31.9 |
| 12         | 5 | 3 |          |        |          | Diff. Lat.      | —     | 1 11 S.                  |              |       |      |
| 1          | 5 | 9 |          |        |          | Lat. in         | —     | 45 17 N.                 | M. Par.      | =     | 30.9 |
| 2          | 6 | 2 |          |        |          | Sum Lat.        | —     | 91 45                    | Mer. D. Lat. | =     | 10.0 |
| 3          | 6 | 0 |          |        |          | Mid. Lat.       | —     | 45 52                    |              |       |      |
| 4          | 6 | 3 | S. S. E. |        |          | Co. M. Lat.     | 44    | 08                       |              |       |      |
| 5          | 6 | 4 |          |        |          | Long. left      | —     | 22 18 W.                 |              |       |      |
| 6          | 7 | 0 |          |        |          | Diff. of Lon.   | 2     | 39 E. or $2^{\circ} 40'$ |              |       |      |
| 7          | 6 | 8 |          |        |          | Long. in        | —     | 19 39 W.                 |              |       |      |
| 8          | 7 | 3 |          |        |          | Direct Course   | —     | $S. 57^{\circ} 22' E.$   |              |       |      |
| 9          | 7 | 5 |          |        |          | Distance        | —     | 131 miles.               |              |       |      |
| 10         | 7 | 1 |          |        |          |                 |       |                          |              |       |      |
| 11         | 7 | 9 |          |        |          |                 |       |                          |              |       |      |
| 12         | 7 | 3 |          |        |          |                 |       |                          |              |       |      |

The courses and winds on the log-board being examined, it appears that the ship goes large, and has no lee-way; therefore the several courses from the log-board are entered in the Traverse Table without alteration.

Next the fathoms and knots belonging to each course are summed up, and the results are put in the column of distances in the Traverse Table; and to these courses and distances, the whole difference of latitude, departure, course and distance made good, are found as above.

Then having the latitude left, and the latitude come to; find the complement of the middle latitude, and with that, and the departure, find the course, &c. by middle latitude sailing.

Or with the course, and meridional difference of latitude, find the difference of longitude, by Mercator's sailing.

NOTE. When the odd fathoms are above five, we allow one knot, but, if under five, nothing is allowed.

EXAMPLE

EXAMPLE II.

June 29, 1792; being yesterday noon in latitude  $25^{\circ} 30' S.$  and longitude  $10^{\circ} 15' E.$  we have sailed till this day noon, as per log-board, in a current setting fourth  $2\frac{1}{2}$  miles an hour, the variation  $1\frac{1}{2}$  point west; required the ship's place?

| LOG-BOARD. |   |   |             |             |        | TRAVERSE TABLE.                  |                                                      |    |               |       |      |
|------------|---|---|-------------|-------------|--------|----------------------------------|------------------------------------------------------|----|---------------|-------|------|
| H          | K | F | Courses.    | Winds.      | L. Way | Courses.                         | Dist.                                                | N. | S.            | E.    | W.   |
| 1          | 6 | 0 | S. W.       | W. N. W.    | 1      | S. by W. $\frac{1}{2}$ W.        | 30                                                   |    | 28, 7         |       | 8, 7 |
| 2          | 6 | 2 |             |             |        | S. by E. $\frac{1}{2}$ E.        | 32                                                   |    | 30, 6         | 9, 3  |      |
| 3          | 6 | 4 |             |             |        | S. $\frac{1}{2}$ E.              | 30                                                   |    | 29, 9         | 2, 9  |      |
| 4          | 6 | 0 |             |             |        | SE. by E. $\frac{1}{2}$ E.       | 39                                                   |    | 18, 4         | 34, 4 |      |
| 5          | 5 | 3 |             |             |        | S. by E. $\frac{1}{2}$ E.        | 60                                                   |    | 57, 4         | 17, 4 |      |
| 6          | 6 | 0 | S. by W.    | W. by S.    | 1      |                                  |                                                      |    |               |       |      |
| 7          | 5 | 1 |             |             |        |                                  | Diff. Lat.                                           |    | 165, 0        | 64, 0 | 8, 7 |
| 8          | 5 | 4 |             |             |        |                                  |                                                      |    |               | 8, 7  |      |
| 9          | 5 | 2 |             |             |        |                                  |                                                      |    |               |       |      |
| 10         | 5 | 3 |             |             |        |                                  |                                                      |    |               | 55, 3 | Dep. |
| 11         | 5 | 5 | S. S. W.    | W.          | 1      | Dir. lat.                        | $2^{\circ} 45' S.$                                   |    |               |       |      |
| 12         | 5 | 2 |             |             |        | Lat. left                        | $25^{\circ} 30' S.$                                  |    | Mer. Parts    | 1583  |      |
| 1          | 5 | 2 |             |             |        | Lat. in                          | $28^{\circ} 15' S.$                                  |    | Mer. Parts    | 1768  |      |
| 2          | 5 | 0 |             |             |        | Sum Lat.                         | $53^{\circ} 45'$                                     |    | M. diff. lat. | 185   |      |
| 3          | 4 | 6 |             |             |        | Mid. lat.                        | $26^{\circ} 52'$                                     |    |               |       |      |
| 4          | 5 | 0 | S. E. by S. | S. W. by S. | 1      | Co. M. lat.                      | $63^{\circ} 08'$                                     |    |               |       |      |
| 5          | 5 | 1 |             |             |        | Long. left                       | $10^{\circ} 15' E.$                                  |    |               |       |      |
| 6          | 5 | 2 |             |             |        | Dif. long.                       | $1^{\circ} 02' E.$ or $1^{\circ} 01' \frac{1}{2} E.$ |    |               |       |      |
| 7          | 5 | 4 |             |             |        | Long. in                         | $11^{\circ} 17' E.$                                  |    |               |       |      |
| 8          | 5 | 4 |             |             |        |                                  |                                                      |    |               |       |      |
| 9          | 6 | 0 |             |             |        |                                  |                                                      |    |               |       |      |
| 10         | 6 | 0 |             |             |        |                                  |                                                      |    |               |       |      |
| 11         | 5 | 4 |             |             |        |                                  |                                                      |    |               |       |      |
| 12         | 5 | 5 |             |             |        |                                  |                                                      |    |               |       |      |
|            |   |   |             |             |        | Course is S. $18^{\circ} 30' E.$ |                                                      |    |               |       |      |
|            |   |   |             |             |        | Distance 174 miles.              |                                                      |    |               |       |      |

The courses and winds on the log-board being examined, it appears that the ship is close hauled on each tack, and one point lee-way being allowed, reduces the courses, and taking a course for the current S. these several courses being corrected by the variation  $1\frac{1}{2}$  point west, give those in the traverse table, to which the whole difference of latitude and departure is to be found as above. And hence the latitude and longitude in may be found, either by middle latitude or Mercator's sailing; for as the ship is near the equator, the difference will be almost insensible.

NOTE. In the two following examples, the courses are corrected to the nearest degrees, as set down in the traverse table, and the odd minutes are rejected.

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EXAM



## EXAMPLE III.

Yesterday at noon we were in latitude  $33^{\circ} 40' N.$  longitude  $16^{\circ} 20'$  west, the sun was observed to set  $50^{\circ} 18'$  from the north point of the compass; we have failed this day noon, as per log-board, in a current setting W. S. W.  $1\frac{1}{2}$  mile per hour; required the ship's place, and her course and distance to the west end of the island of Madeira?

| LOG-BOARD. |   |   |             |          |        | TRAVERSE TABLE.    |            |    |        |      |       |
|------------|---|---|-------------|----------|--------|--------------------|------------|----|--------|------|-------|
| H          | K | F | Courses.    | Winds.   | L. Way | Courses.           | Dist.      | N. | S.     | E.   | W.    |
| 1          | 6 | 2 | S. by W.    | W.       | 0      | S. $01^{\circ} E.$ | 40         |    | 40, 0  | 0, 7 |       |
| 2          | 6 | 0 |             |          |        | S. $10 W.$         | 70         |    | 68, 9  |      | 12, 3 |
| 3          | 6 | 3 |             |          |        | S. $44 W.$         | 58         |    | 41, 7  |      | 40, 3 |
| 4          | 7 | 0 |             |          |        | S. $55 W.$         | 36         |    | 20, 6  |      | 29, 5 |
| 5          | 7 | 2 |             |          |        |                    |            |    |        |      |       |
| 6          | 7 | 3 |             |          |        |                    | Diff. Lat. |    | 171, 2 | 0, 7 | 82, 0 |
| 7          | 7 | 2 | S. W. by S. | W. by N. | 1      |                    |            |    |        |      | 0, 7  |
| 8          | 7 | 2 |             |          |        |                    |            |    |        |      |       |
| 9          | 7 | 4 |             |          |        |                    |            |    |        | Dep. | 81, 3 |
| 10         | 7 | 6 |             |          |        |                    |            |    |        |      |       |
| 11         | 7 | 4 |             |          |        |                    |            |    |        |      |       |
| 12         | 8 | 1 |             |          |        |                    |            |    |        |      |       |
| 1          | 8 | 0 |             |          |        |                    |            |    |        |      |       |
| 2          | 8 | 5 |             |          |        |                    |            |    |        |      |       |
| 3          | 8 | 2 |             |          |        |                    |            |    |        |      |       |
| 4          | 7 | 5 | S. W. by W. | N. W.    | 0      |                    |            |    |        |      |       |
| 5          | 7 | 3 |             |          |        |                    |            |    |        |      |       |
| 6          | 6 | 6 |             |          |        |                    |            |    |        |      |       |
| 7          | 6 | 4 |             |          |        |                    |            |    |        |      |       |
| 8          | 6 | 0 |             |          |        |                    |            |    |        |      |       |
| 9          | 6 | 2 |             |          |        |                    |            |    |        |      |       |
| 10         | 6 | 1 |             |          |        |                    |            |    |        |      |       |
| 11         | 6 | 3 |             |          |        |                    |            |    |        |      |       |
| 12         | 6 | 1 |             |          |        |                    |            |    |        |      |       |

Before the courses can be corrected to put into the Traverse Table, the variation of the compass must be found from the sun's true amplitude.

The declination is  $22^{\circ} 30' N.$

As cos.  $33^{\circ} 40' : \text{rad.} :: \sin. 22^{\circ} 30' : \sin. 27^{\circ} 22'.$

So that the true amplitude =  $62^{\circ} 38' W.$

Mag. amplitude =  $50^{\circ} 18' W.$

Variation =  $12^{\circ} 20' W.$

The courses on the log-board being corrected by this variation and the lee-way, will give the courses fitted for the Traverse Table.

|               |    |                     |                 |   |                           |              |
|---------------|----|---------------------|-----------------|---|---------------------------|--------------|
| Lat. left     | —  | $33^{\circ} 40' N.$ | Madeira's lat.  | — | $32^{\circ} 30' N.$       | M. Parts 206 |
| Diff. lat.    | —  | 2 51 S.             | Lat. in         | — | $30^{\circ} 49' N.$       | 194          |
| Lat. in       | —  | $30^{\circ} 49' N.$ | Diff. lat.      | — | 1 41 = 101 miles          | 119          |
| Sum Lat.      | 64 | 29                  | Sum lats,       | — | 63 19                     |              |
| Mid. Lat.     | —  | 32 14               | Mid. lat.       | — | 31 39                     |              |
| Co. Mid. Lat. | —  | 57 46 N.            | Co. mid. lat.   | — | 58 21                     |              |
| Long. left    | —  | 16 20 W.            | Madeira's long. | — | 17 26 W.                  |              |
| Diff. Long.   | —  | 1 36 W.             | Long. in        | — | 17 56 W.                  |              |
| Long. in      | —  | 17 56 W.            | Diff. long.     | — | 0 30 E.                   |              |
|               |    |                     | The course N.   | — | 14 30 E. dist. 104 miles. |              |

In the work for the amplitude, the latitude at sun-set was taken the same as at noon; for although there were about 46 miles of southing in that time, and so the latitude at sun-set was about  $32^{\circ} 54'$  yet the amplitude being only about  $15'$  less, the alteration in variation would scarcely affect the difference of latitude and departure found from the courses so corrected.

E X A M P L E IV.

Yesterday at Noon we were in Latitude  $19^{\circ} 30'$  S. and Longitude  $0^{\circ} 10'$  E. This Forenoon we observed the Sun's Altitude to be  $10^{\circ} 40'$  when he was  $80^{\circ} 30'$  from the North Point of the Compass, Declination being then  $17^{\circ} 27'$  N. we have failed till this Day Noon, as per Log-Board, in a Current setting by the Compass W. N. W.  $\frac{1}{2}$  a Mile an Hour. Required the Ship's Place and her direct Course and Distance to the Island of St. Helena.

Merena.

LOG-BOARD.

TRAVERSE TABLE.

| H. | K. | F. | Courses. | Winds.   | Lee-way. |
|----|----|----|----------|----------|----------|
| 1  | 6  | 7  | N. by E. | E. by N. | 1        |
| 2  | 6  | 2  |          |          |          |
| 3  | 6  | 4  |          |          |          |
| 4  | 6  | 3  |          |          |          |
| 5  | 6  | 1  |          |          |          |
| 6  | 6  | 0  |          |          |          |
| 7  | 5  | 8  | North.   | E. N. E. | 1        |
| 8  | 5  | 4  |          |          |          |
| 9  | 5  | 0  |          |          |          |
| 10 | 5  | 3  |          |          |          |
| 11 | 5  | 6  |          |          |          |
| 12 | 5  | 9  |          |          |          |
| 1  | 5  | 7  |          |          |          |
| 2  | 6  | 4  | N. N. W. | N. E.    | 1        |
| 3  | 6  | 8  |          |          |          |
| 4  | 7  | 0  |          |          |          |
| 5  | 7  | 3  |          |          |          |
| 6  | 7  | 6  |          |          |          |
| 7  | 7  | 5  |          |          |          |
| 8  | 7  | 0  |          |          |          |
| 9  | 7  | 2  |          |          |          |
| 10 | 7  | 4  |          |          |          |
| 11 | 6  | 3  |          |          |          |
| 12 | 6  | 0  |          |          |          |

| Courses.           | Dist. | N.    | S.         | E.   | W.   |
|--------------------|-------|-------|------------|------|------|
| N. $13^{\circ}$ W. | 38    | 37.0  |            |      | 8.5  |
| N. $25^{\circ}$ W. | 39    | 35.3  |            |      | 16.5 |
| N. $47^{\circ}$ W. | 76    | 51.8  |            |      | 55.6 |
| N. $81^{\circ}$ W. | 12    | 1.9   |            |      | 11.9 |
|                    |       | 126.0 | Diff. Lat. | Dep. | 92.5 |

|      |                     |      |                  |     |                     |
|------|---------------------|------|------------------|-----|---------------------|
| Lat. | $19^{\circ} 30'$ S. | Alt. | $10^{\circ} 40'$ | Dec | $17^{\circ} 27'$ N. |
|      | 90 00               |      | 90 00            |     | 90 00               |

Co. Alt. 79 20 P. Dist. 107 27

|          |        |          |         |
|----------|--------|----------|---------|
| Co. lat. | 70 30  | Co. Sec. | 0,02565 |
| Co. Alt. | 79 20  | Co. Sec. | 0,00757 |
| P. Dist. | 107 27 |          |         |

Sum 257 17

|                   |        |           |         |
|-------------------|--------|-----------|---------|
| $\frac{1}{2}$ Sum | 128 38 | Log. Sine | 9,89274 |
| P. Dist.          | 107 27 |           |         |

|      |       |           |         |
|------|-------|-----------|---------|
| Rem. | 21 11 | Log. Sine | 9,55793 |
|------|-------|-----------|---------|

2)19,48389

|            |                     |             |
|------------|---------------------|-------------|
| Diff. Lat. | $2^{\circ} 06'$ N.  | Mer. Parts. |
| Lat. left  | $19^{\circ} 30'$ S. | 1193        |

|         |                    |      |
|---------|--------------------|------|
| Lat. in | $17^{\circ} 24'$ S | 1060 |
|---------|--------------------|------|

|           |                      |                     |
|-----------|----------------------|---------------------|
| Sum. Lat. | $2^{\circ} 36' 54''$ | Mer. Diff. Lat. 133 |
|-----------|----------------------|---------------------|

|           |                                      |
|-----------|--------------------------------------|
| Mid. Lat. | $18^{\circ} 27'$<br>$90^{\circ} 00'$ |
|-----------|--------------------------------------|

|               |                  |
|---------------|------------------|
| Co. Mid. Lat. | $71^{\circ} 33'$ |
|---------------|------------------|

|                |                    |
|----------------|--------------------|
| Longitude left | $00^{\circ} 10'$ E |
| Diff. Long.    | $1^{\circ} 38'$ W. |

|               |                    |
|---------------|--------------------|
| Present long. | $1^{\circ} 28'$ W. |
|---------------|--------------------|

Co. S. True Azimu. =  $56^{\circ} 30' - 9,74194$

|              |                               |
|--------------|-------------------------------|
| True Azimuth | $113^{\circ} 00'$ from the S. |
|              | $180^{\circ} 00'$             |

|              |                              |
|--------------|------------------------------|
| True Ditto   | $67^{\circ} 00'$ from the N. |
| Mag. Azimuth | $80^{\circ} 30'$ from the N. |

Variation  $13^{\circ} 30'$  W.

Lat. in  $17^{\circ} 24'$  S. Long. in  $1^{\circ} 28'$  W. M.P. 1060  
St. Hel. L.  $15^{\circ} 55'$  S. St. Hel. Lo.  $5^{\circ} 46'$  W. M.P. 968

|            |                 |             |                 |            |    |
|------------|-----------------|-------------|-----------------|------------|----|
| Diff. Lat. | $1^{\circ} 29'$ | Diff. Long. | $4^{\circ} 18'$ | M. D. Lat. | 92 |
|            | 60              |             | 60              |            |    |

In Miles 89 In Miles 258

With the Meridional Difference of Latitude and Difference of Longitude, the Direct Course to St. Helena is found S.  $70^{\circ} 22'$  W. and with that Course and the proper Difference of Latitude the Distance is found 265 Miles.

In this Example the Azimuth is worked with Yesterday's Latitude and Declination, but had it been worked with this Day's, the Variation would have been  $12^{\circ} 26'$  W.

187  
JOURNAL  
OF A  
VOYAGE  
FROM  
LONDON TO MADEIRA,  
AND  
TENERIFFE,  
IN THE  
FRANCES, OF LONDON,  
WILLIAM HEATHER, COMMANDER,  
KEPT BY  
JOSEPH WYATT, MATE.

Departure taken from the Lizard in Latitude  $49^{\circ}57'$  N. Longitude  $5^{\circ}14'$  W. bound for Funchal, in Madeira, in Latitude  $32^{\circ}38'$  N. Longitude  $17^{\circ}5'$  W. and to Teneriffe in Latitude  $28^{\circ}13'$  N. Longitude  $16^{\circ}26'$  W. bearing from the Lizard-Point S.  $26^{\circ}58'$  W. distance 1166 Miles.

*Begun April 11th, 1792.*

In the following JOURNAL are exemplified, the Manner of allowing for the Variation, Lee-way, Lying-to, Calms, Currents, Heave of the Sea, &c. and to correct the Dead Reckoning, by an Observation, in all Cafes; with most of the Occurrences that commonly happen at Sea, and the Ship's Way pricked off on MERCATOR's Chart.

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|                                 |                                                                                                                                                                                                                                                                                             |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wednesday<br>April 11,<br>1792. | At 5 A. M. the pilot came on board; then weighed and failed from Tower Wharf; at 11 came to with the best bower at Blackwall. Wind S. S. W.                                                                                                                                                 |
| Thursday<br>12.                 | Fresh gales and cloudy weather, with rain.<br>At 5 A. M. weighed and failed; at 9 came to an anchor at Gravesend, and cleared ship. Wind from S. S. W. to N. N. W.                                                                                                                          |
| Friday<br>13.                   | At 4 P. M. weighed and failed, moderate weather; at 9 came to with the best bower at the Nore in $9\frac{1}{2}$ fathoms, fresh gales; at 4 A. M. weighed and failed; at 11 came to anchor in the Downs in 7 fathoms, Deal Castle bearing W. $\frac{1}{2}$ S. distant 3 miles. Wind W. by S. |
| Saturday<br>14.                 | At 1 P. M. sent the Pilot on shore. These 24 hours, the first and middle parts moderate and fair, the latter part strong gales and cloudy; hoisted the boats in.                                                                                                                            |
| Sunday<br>15.                   | Strong gales and cloudy; at 2 P. M. veered out the long service of the best bower, got top-gallant yards down; at 4 P. M. struck yards and top-masts. These 24 hours had very hard gales of wind. Wind W. by S.                                                                             |
| Monday<br>16.                   | These 24 hours, for the most part, fresh gales; at 4 A. M. hove up the best bower, and let go the small bower; at 9 hove up the small bower, and let go the best bower again; people employed in making points and gaskets.                                                                 |
| Tuesday<br>17.                  | At 6 P. M. strong gales with heavy rain; at 8 veered out the long service, and let go the sheet anchor under foot; at 9 A. M. hove up the sheet anchor. Wind variable from S. by W. to W.                                                                                                   |
| Wednesday<br>18.                | These 24 hours, for the first and middle part, moderate and fair; the latter part, strong gales. Wind W. by S.                                                                                                                                                                              |
| Thursday<br>19.                 | These 24 hours, fresh gales and fair; at 3 P. M. got top-gallant mast down; at 10 A. M. got yards and top-mast up. Wind E. S. E.                                                                                                                                                            |

| H. | K. | F. | Courfes.                    | Winds.              | Lee-way. | REMARKS on Board, Friday April 20th, 1792. |
|----|----|----|-----------------------------|---------------------|----------|--------------------------------------------|
| 2  |    |    | S. by W. $\frac{1}{4}$ W.   | N. $\frac{1}{2}$ W. |          | At 2 P. M. hove short.                     |
| 4  |    |    |                             |                     |          | At 4 weighed and failed in Co. with        |
| 6  |    |    |                             |                     |          | 40 Gun Man of War, and 20 Sail of          |
| 8  |    |    |                             |                     |          | Merchantmen.                               |
| 10 |    |    | W. $\frac{1}{2}$ S.         | N. by W.            |          | At 6 S. Foreland bore N. N. W. dist. 4 M.  |
| 12 |    |    | S. W by W. $\frac{1}{4}$ W. |                     |          | At 2 A. M. Fairlee bore N. dist. 6 M.      |
| 2  |    |    |                             |                     |          | At 6 Beachy bore N. by W. 6 Miles.         |
| 4  |    |    | W. N. W. $\frac{1}{2}$ W.   | N. $\frac{1}{2}$ W. |          | At 8 Beachy bore N. E. by E. 9 Miles.      |
| 6  |    |    | W. S. W.                    | N. by E.            |          | Fresh Gales and clear, several Ships       |
| 8  |    |    |                             |                     |          | standing up Channel; close reefed          |
| 10 |    |    |                             |                     |          | both Topfails.                             |
| 12 |    |    |                             |                     |          | At 12 Bembridge P. bore W. N. W. 17 M.     |
|    |    |    |                             |                     |          | Still in Company with the Fleet.           |
|    |    |    |                             |                     |          |                                            |
|    |    |    |                             |                     |          |                                            |
| H. | K. | F. | Courfes.                    | Winds.              | Lee-way. | REMARKS on board, Saturday, Ap. 21.        |
| 2  | 4  | 0  | W. S. W.                    | N. by E.            |          |                                            |
| 4  | 4  | 6  | W. $\frac{1}{4}$ S.         |                     |          |                                            |
| 6  | 5  | 5  |                             |                     |          | Fresh Gales and clear.                     |
| 8  | 5  | 0  |                             |                     |          | At 4 P. M. parted with the Fleet, they     |
| 10 | 5  | 1  |                             |                     |          | being bound to Spithead. Dunno             |
| 12 | 4  | 6  |                             |                     |          | bearing W. N. W. distant 21 Miles.         |
| 2  | 5  | 0  |                             |                     |          | At 5 let out one Reef of each Top-sail.    |
| 4  | 4  | 4  |                             |                     |          | At 7 A. M. Portland Light bore W. N.       |
| 6  | 4  | 5  |                             |                     |          | W. 9 Miles.                                |
| 8  | 4  | 0  |                             |                     |          | At 10 A. M. it bore N. E. 12 Miles, 14     |
| 10 | 4  | 2  | S by W. $\frac{1}{2}$ W.    | N. N. E.            |          | Sail in Sight.                             |
| 12 | 5  | 0  |                             |                     |          |                                            |
|    |    |    |                             |                     |          |                                            |
|    |    |    |                             |                     |          |                                            |

Being upon the Coast this last Day, the Log is hove, and the Bearings and Distances of Lands, Rocks, Sands, &c. as you approach them must always be set down, and are of the greatest consequence, especially in bad Weather, or when you are in Danger of being drove out of your true Course, in the Night, or in a Fog; so that you may at any Time determine, by your Reckoning, or the Chart, the Ship's Place, and sail Courses and Distances as Circumstances require, in order to pass Places of Danger, and to have it always in your Power to take your Departure from some known Place, in case you should be drove out to Sea in the Night or in Foggy Weather, when no Land can be seen. For it sometimes happens, that in working to Windward in the English Channel, E. of Dunnose, Ships by making too long a Board, have got upon a Sand called the Ower, which lies from Dunnose E.  $\frac{1}{4}$  N. 25 Miles. It is therefore absolutely necessary to have good Draughts of the Coasts you sail upon, unless you are well acquainted with them indeed.

| H. | K. | F. | Courfes.                    | Winds. | Lee-way. | REMARKS on board, Sunday, Apr. 25d, 1792,            |
|----|----|----|-----------------------------|--------|----------|------------------------------------------------------|
| 2  |    |    |                             |        |          | These 24 Hours moderate Gales, and fair Weather.     |
| 4  |    |    |                             |        |          |                                                      |
| 6  |    |    |                             |        |          |                                                      |
| 8  | 4  |    | S.W. by W. $\frac{1}{2}$ W. | N. E.  |          | At 6 P. M. the Lizard bore N. by E. $\frac{1}{2}$ E. |
| 10 | 4  | 5  |                             |        |          | Distance 6 Leagues, from which I take                |
| 12 | 5  |    |                             |        |          | my Depart. it being in the Lat. of $49^{\circ} 57'$  |
| 2  | 5  |    |                             |        |          | N. and Long. $5^{\circ} 14'$ West of London.         |
| 4  | 5  | 5  | S. W. $\frac{1}{2}$ W.      |        |          | Several Sail in Sight, standing to Westward.         |
| 6  | 5  | 5  |                             |        |          |                                                      |
| 8  | 5  | 5  |                             |        |          | At Noon, Uphant N. $80^{\circ} 26'$ W. Distance      |
| 10 | 5  | 5  |                             |        |          | 54 Miles.                                            |
| 12 | 6  |    |                             |        |          | Variation $2 \frac{1}{2}$ Point Westerly             |

| Courfe                    | Diff. | S. | W  | Lat. by<br>D. R. | Lat. by Obs. | Mer. Diff.      | Diff. Lon.      | Long. in.          | Bearing and<br>Diff.                                 |
|---------------------------|-------|----|----|------------------|--------------|-----------------|-----------------|--------------------|------------------------------------------------------|
| S. $26^{\circ} 30'$<br>W. | 107   | 96 | 48 | 48. 21 N.        |              | $0^{\circ} 48'$ | $1^{\circ} 14'$ | $6^{\circ} 28' W.$ | Funch. S. $27^{\circ}$<br>W. D. $105^{\circ} 38' M.$ |

The Lizard bearing N. by E.  $\frac{1}{2}$  E. Dist. 6 Leagues from the Ship is the same as if the Ship had sailed from the Lizard 6 Leagues or 18 Miles upon the opposite, or S. by W.  $\frac{1}{2}$  W. Point of the Compass, and allowing for the Variation, as before taught, makes it S. half E. Dist. 18 M. which is to be set down as the first Course and Distance in the following Traverse Table.

The first Course steered by Compass is S. W. by W.  $\frac{1}{2}$  W. which, allowing for the Variation, makes S. W. by S. half W. and the Sum of all the Distances sailed on that Course till two o'Clock, when it alters, is 18 Miles and an half, which being doubled, because the Log is heaved every two Hours, gives 37 Miles; so the second Course and Dist. to be set down in the Traverse Table is S. W. by S. half W. 37 Miles. In like Manner the second Course steered is S. W.  $\frac{1}{2}$  W. and the Variation allowed makes it S. S. W. half W. and the Dist. on that Course summed up and doubled, gives 56 Miles; therefore the third Course and Dist. to be set down in the Traverse Table is S. S. W. half W. 56 Miles. Having found the whole Difference of Latitude and Departure made upon the several Courses, I then mark down upon my Slate or Paper what every Thing that is to be found comes to, and afterwards set them down in their proper Columns as above.

| TRAVERSE TABLE.             |       |    |      |     |      |
|-----------------------------|-------|----|------|-----|------|
| Courfes.                    | Diff. | N. | S.   | E.  | W.   |
| S. $\frac{1}{2}$ E.         | 18    |    | 17.9 | 1.8 |      |
| S.W. by S. $\frac{1}{2}$ W. | 37    |    | 28.6 |     | 23.5 |
| S. S. W. $\frac{1}{2}$ W.   | 56    |    | 49.4 |     | 26.4 |
|                             |       |    | 95.9 |     | 49.9 |
|                             |       |    |      | 1.8 |      |
|                             |       |    |      |     | 48.1 |

Now to Diff. of Lat.  $95.9$  S. and Dep.  $48.1$  W. the Course is S.  $26^{\circ} 30'$  W. Dist. 107 Miles; then Lat. sailed from, or Lizard's Lat.  $49^{\circ} 57' N.$  Diff. of Lat. — — —  $1^{\circ} 36' S.$  Lat. in, or Ship's Lat. — — —  $48^{\circ} 21' N.$  Sum of Lats. — — —  $98^{\circ} 18'$  Middle Lat. — — —  $49^{\circ} 09'$  Com. of Middle Lat. — — —  $40^{\circ} 51'$  Then with this Com. of Mid. Lat.  $40^{\circ} 51'$ , or  $41^{\circ}$  found as a Course among the Degrees, and the Dep.  $48.1$  in its Column, in the Dist. Col. stands 74, which is the Diff. of Long.

Or, with the Course  $26^{\circ} 30'$  and Meridional Diff. of Lat.  $147$ , the Diff. of Long. is found to be nearly 74 by Mercator's sailing.

|                                              |                    |                                                                                    |
|----------------------------------------------|--------------------|------------------------------------------------------------------------------------|
| Longitude sailed from, or Lizard's Longitude | $5^{\circ} 14' W.$ | } This being the first Day since leaving the Land, the Departure is the Mer. Dist. |
| Difference of Longitude                      | 74 Miles           |                                                                                    |
| Longitude in, or Ship's Longitude            | $6^{\circ} 28' W.$ |                                                                                    |

To find the Bearings and Distance of Uphant.

|                    |                     |                    |      |              |                    |
|--------------------|---------------------|--------------------|------|--------------|--------------------|
| Latitude in        | $48^{\circ} 21' N.$ | Mer. Parts         | 3323 | Longitude in | $6^{\circ} 28' W.$ |
| Uphant's Lat.      | $48^{\circ} 30' N.$ | Mer. Parts         | 3337 | Uphant Long. | $5^{\circ} 5' W.$  |
| Difference of Lat. | 9                   | Mer. Diff. of Lat. | 14   | Diff. Long.  | $1^{\circ} 23'$    |

With the Mer. Diff. and Diff. Long. Uphant is found to bear N.  $80^{\circ} 26' E.$  and with that Bearing, taken as a Course, and the proper Difference of Latitude, the Distance is found 54 Miles.—The bearings and distance to Funchal is found in the like manner.





| H. | K. | F. | Courses.    | Winds.   | Lee-way.      | REMARKS on Board, Tuesday, Apr. 24, 1792.                  |
|----|----|----|-------------|----------|---------------|------------------------------------------------------------|
| 2  | 4  |    | S. W.       | W. N. W. | 0             | These 24 Hours moderate Gales and clear Weather.           |
| 4  | 4  |    |             |          |               | At 6 P. M. saw a Ship to the Westward.                     |
| 6  | 4  |    |             |          |               |                                                            |
| 8  | 4  | 4  | S. W. by S. | W. by N. | $\frac{1}{2}$ | Observed the Sun's Mer. Alt. at Noon $90^{\circ} 61' 40''$ |
| 10 | 4  | 5  |             |          |               |                                                            |
| 12 | 4  | 6  |             |          |               |                                                            |
| 2  | 4  | 5  | S. S. W.    | West     | 1             | Zenith Distance — 28 20 S.                                 |
| 4  | 4  |    |             |          |               | Declination — 17 03 N.                                     |
| 6  | 4  |    |             |          |               | Latitude — 45 23 N.                                        |
| 8  | 4  |    |             |          |               | At Noon C. Ortegual S. $10^{\circ} 21' E$ . Dist. 99 M.    |
| 10 | 4  |    |             |          |               | Variation $1\frac{1}{2}$ Point Westerly.                   |
| 12 | 4  |    |             |          |               |                                                            |

| Courfe.            | Diff. | Lat. | Dep. | Lat. by D. R. | Lat. by Obs. | Mer. Dist.       | Diff. Long. | Long. in | Bearings and Dist.                                 |
|--------------------|-------|------|------|---------------|--------------|------------------|-------------|----------|----------------------------------------------------|
| $8^{\circ} 30' W.$ | 97    | 96   | 14   | 45. 12        | 45. 23       | $10^{\circ} 53'$ | 00 21       | 8. 01    | unchal S. $28^{\circ} 47' W.$<br>Dist. 87 3 Miles. |

By allowing for Variation and Leeway the Work will be as follows:

With the Diff. of Lat. and Dep. the Course is found S.  $8^{\circ} 30' W.$  and the Dist. 97 Miles.

Diff. Lat.  $10^{\circ} 36' S.$  Mer. Parts.

Latitude left 46 48 N. 3185

Lat. in by D. R. 45 12 3047

Sum. Lat. 92 00 Mer. Diff. Lat. 138

Middle Lat. 46 00

90 00

Com. Mid. Lat. 44 00

## TRAVERSE TABLE.

| Courses.                  | Dist. | N.    | S.    | E.   | W.    |
|---------------------------|-------|-------|-------|------|-------|
| S. S. W. $\frac{1}{2} W.$ | 24    |       | 21. 2 |      | 11. 3 |
| S. by W.                  | 36    |       | 35. 3 |      | 7. 0  |
| S. $\frac{1}{2} E.$       | 40    |       | 39. 8 | 3. 9 |       |
| Diff. Lat.                |       | 96. 3 |       | 3. 9 | 18. 3 |
|                           |       |       |       |      | 3. 9  |
|                           |       |       |       | Dep. | 14. 4 |

Longitude left  $7^{\circ} 47' W.$   
Diff. Long. 21 W.

Longitude in by Account 8 08

Here the Latitude by Observation differing from the Latitude by Account, I correct for the true Longitude; and as this is the first Observation got since leaving the Land, I correct by Case I. as follows:

Lizard's Lat.  $49^{\circ} 57' N.$  Mer. Parts 3470

Lat. by D. R. 45 12 N. Mer. Parts 3047

Mer. Diff. Lat. by Account 423

Lizard's longitude  $5^{\circ} 14' W.$

Long in by Account 8 8 W.

Diff. of Long. by Account 2 54

60

In Miles 174

Lizard's Lat.  $49^{\circ} 57' N.$  Mer. Parts 3470

Obs. Lat. 45 23 N. Mer. Parts 3063

Mer. Diff. Lat. by Observation 407

To find the direct Course and Distance to Cape Ortegual.

Lat. in  $45^{\circ} 23' N.$  Mer. Parts 3063

Cape's Lat. 43 46 N. Mer. Parts 2926

Diff. Lat. 1 37 Mer. Diff. 137

Diff. Longitude 25

With the Mer. Diff. of Lat. and Diff. of Long. the direct course to Cape Ortegual is

found S. by E. and with that Course and the proper Diff. of Lat. 97, the Distance is found

to be 99 Miles.

With the Mer. Diff. of Lat. and Diff. Long. by Account, the Ship's direct Course from the Lizard is found to be S.  $22^{\circ} 22' W.$  or S. S. W.

With that Course, and the Mer. Diff. of Lat. by Observation, the Diff. of Long. since leaving the Lizard is found 167 Miles equal to  $2^{\circ} 47' W.$

Lizard's longitude  $5^{\circ} 14' W.$

Longitude in 8 01

With the Course  $22^{\circ} 22'$  or 2 Points, the proper Diff. of Lat. 274 Miles, the true Mer. Dist. is found 313 Miles.

Long. in  $8^{\circ} 01' W.$

Cape's longitude 7 36 W.

Diff. Longitude 25

With the Mer. Diff. of Lat. and Diff. of Long. the direct course to Cape Ortegual is

found S. by E. and with that Course and the proper Diff. of Lat. 97, the Distance is found

to be 99 Miles.

B b

| H.                | K.         | F.         | Courses.                  | Winds.        | Lee-way.     | REMARKS on Board, Wednesday, April 25th, 1792.                 |                |                    |                                                |
|-------------------|------------|------------|---------------------------|---------------|--------------|----------------------------------------------------------------|----------------|--------------------|------------------------------------------------|
| 2                 | 3          | 5          | S. by W. $\frac{1}{4}$ W. | West.         | 1            | These 24 Hours moderate Gales and clear Weather.               |                |                    |                                                |
| 4                 | 3          | 5          |                           |               |              |                                                                |                |                    |                                                |
| 6                 | 3          | 5          |                           |               |              |                                                                |                |                    |                                                |
| 8                 | 3          |            |                           |               |              | At 8 P.M. set up the Mizzen Top-Mast Shrouds and Back-Stays.   |                |                    |                                                |
| 10                | 3          | 5          |                           |               |              | At Noon Cape Ortegal S. $14^{\circ} 28'$ E. Distance 23 Miles. |                |                    |                                                |
| 11                | 3          |            |                           |               |              |                                                                |                |                    |                                                |
| 2                 | 3          |            |                           |               |              |                                                                |                |                    |                                                |
| 4                 | 3          |            | S. by W.                  | W. by S.      | 1            |                                                                |                |                    |                                                |
| 6                 | 3          |            |                           |               |              |                                                                |                |                    |                                                |
| 8                 | 3          |            |                           |               |              |                                                                |                |                    |                                                |
| 10                | 3          |            |                           |               |              |                                                                |                |                    |                                                |
| 12                | 3          |            |                           |               |              | Variation $1\frac{1}{2}$ point Westerly, per Amplitude.        |                |                    |                                                |
| Courfe            | Diff. Lat. | Diff. Lat. | Dep.                      | Lat. by D. R. | Lat. by Obs. | Mer. Dist                                                      | Diff. of Long. | Long. in           | Bearings and Dist.                             |
| S. $9^{\circ}$ E. | 76         | 75 S.      | 12 E.                     | 44.08         |              | 1.41                                                           | 17 E.          | $7^{\circ} 44'$ W. | runchals. $32^{\circ} 14'$ W. Dist. 817 Miles. |

With the Difference of lat. and Departure the Courfe is found S.  $9^{\circ}$ . and the Distance 76 Miles.

Diff. lat.  $1^{\circ} 15'$  S. Mer. Parts

Yesterday's lat. 45  $23'$  N. 3063

Latitude in 44  $08'$  N. 2957

Sum. lat. 39  $31'$  106

Middle latitude 44  $45'$

Comp. Mid. lat. 45  $15'$

| TRAVERSE TABLE.           |                       |      |                    |      |    |
|---------------------------|-----------------------|------|--------------------|------|----|
| Courses.                  | Diff.                 | N.   | S.                 | E.   | W. |
| S. $\frac{1}{2}$ E.       | 46                    |      | 45.8               | 4.3  |    |
| S. by E. $\frac{1}{4}$ E. | 30                    |      | 29.1               | 7.3  |    |
|                           | Diff. lat.            | 74.9 | 11.8               | Dep. |    |
|                           | Yesterday's longitude |      | $8^{\circ} 01'$ W. |      |    |
|                           | Diff. longitude       |      | 0 $17'$ E.         |      |    |
|                           | Longitude in          |      | 7 $44'$ W.         |      |    |

This Day's Departure being subtracted from the Meridional Distance of Yesterday, gives  $1^{\circ} 41'$  the Meridional Distance of To-day.

To find the Bearings and Distance of Cape Ortegal.

|             |             |                 |      |                  |                    |
|-------------|-------------|-----------------|------|------------------|--------------------|
| Latitude in | 44 $08'$ N. | Mer. Parts      | 2957 | Longitude in     | $7^{\circ} 44'$ W. |
| Cape's lat. | 43 $46'$ N. | Mer. Parts      | 2916 | Cape's longitude | 7 $30'$ W.         |
| Diff. lat.  | 22          | Mer. Diff. lat. | 31   | Diff. longitude  | 8                  |

With the Mer Difference of latitude and Difference of longitude Cape Ortegal is found to bear S.  $14^{\circ} 28'$  E. and with that Bearing taken as a Course, and the proper Difference of latitude, the Distance is found 23 Miles.

NOTE. When the Tenths on any Side are more than 5, or half a Mile, you must call that Side one more than you found it to be; but when they are less than 5, then you need take no notice of them; as in the above the Difference of latitude and Departure are 74.9 and 11.8, which I call 75 and 12, because the Tenths are above 5.

But when you take the Difference of latitude and Departure to find the Course by then take them in Miles and Tenths; the same may be observed in casting up the Knots and Fathoms.

If when doubled, the Tenths are more than 5, set one Mile more in the Traverse Table; but if less, omit them, as there are no Tenths in the Distance Column.



| H.       | K.                                 | F.            | Courfes. | Winds.           | Lee-way.        | REMARKS on Board, Thursday<br>April, 26, 1792.                                                   |                   |          |                                              |
|----------|------------------------------------|---------------|----------|------------------|-----------------|--------------------------------------------------------------------------------------------------|-------------------|----------|----------------------------------------------|
| 2        | 3                                  | 5             | West.    | S. S. W.         | 3               | These 24 Hours hard Gales and<br>squally, with small Rain—Hand-<br>ed the Fore and Main Courfes. |                   |          |                                              |
| 4        | 3                                  | 5             |          |                  |                 |                                                                                                  |                   |          |                                              |
| 6        | 3                                  | 5             |          |                  |                 |                                                                                                  |                   |          |                                              |
| 8        | Lay to, up N. W. by N. off N. by E |               |          |                  | 5               | At 8 P. M. ſaw a Ship to Windward<br>with Jury Maſts up.                                         |                   |          |                                              |
| 10       | Drift 1 ½ Mile per Hour W.         |               |          |                  |                 |                                                                                                  |                   |          |                                              |
| 12       |                                    |               |          |                  |                 |                                                                                                  |                   |          |                                              |
| 2        | Up N. W. off North W. by S.        |               |          |                  | 5               | Set the Courſes cloſe reefed—more<br>moderate.                                                   |                   |          |                                              |
| 4        | Drift 1 ½ Mile per Hour            |               |          |                  |                 |                                                                                                  |                   |          |                                              |
| 6        |                                    |               |          |                  |                 |                                                                                                  |                   |          |                                              |
| 8        | 5                                  |               | S. W.    | N. W. by W. ½ W. | ½               | Set the Top-fails cloſe reefed.                                                                  |                   |          |                                              |
| 10       | 5                                  |               |          |                  |                 | C. Finiſterre S. 28° 37' W. Diſt. 82 M.                                                          |                   |          |                                              |
| 12       | 5                                  |               |          |                  |                 | Variation 1 ½ Point Weſterly.                                                                    |                   |          |                                              |
| Courſe.  | Diſt.                              | Diff.<br>Lat. | Dep.     | Lat. by<br>D. R. | Lat. by<br>Obſ. | Mer. Diſt.                                                                                       | Diff. of<br>Long. | Long. in | Bearings and Diſtance.                       |
| S81°21'W | 25                                 | 4             | 25       | 44° 04'          |                 | 2.6                                                                                              | 36                | 8. 20W.  | Funchal S. 30° 53' W.<br>Diſtance 799 Miles. |

Taking the Middle Points (viz. N. by W. and N. N. W.) between the Point to which the Ship comes up to, and the Point she fell off to for the second and third Courfes, as taught in the Rules for lying to, and then allowing as before for Variation and leeway, the Traverse Table will stand as follows:

With the Diff. of lat. and Dep. the Courfe is found S.  $81^{\circ} 21'$  W. and the Distance 25 M.

Diff. of lat.  $00^{\circ} 04'S$ . Mer. Parts. 2957

Yesterday's lat. 44 08 N. 2951

Lat. in 44 04 N. 2951

Sum. lat. 88 12 Mer. Diff. lat. 6

Middle latitude 44 06  
90 00

Comp. Mid. lat. 45 54

TRAVERSE TABLE.

| Courfes.                  | Diff.      | N.   | S.   | E.    | W.   |
|---------------------------|------------|------|------|-------|------|
| W. N. W. $\frac{1}{4}$ W. | 21         | 7.1  |      |       | 19.8 |
| N. N. E. $\frac{1}{4}$ E. | 9          | 7.7  |      | 4.6   |      |
| N. by E. $\frac{1}{4}$ E. | 9          | 8.5  |      | 3.0   |      |
| S. S. W. $\frac{1}{4}$ W. | 30         |      | 27.1 |       | 12.8 |
|                           |            | 23.3 | 27.1 | 7.6   | 32.6 |
|                           |            |      | 23.3 |       | 7.6  |
|                           | Diff. lat. | 3.8  | Dep. | 125.0 |      |

The Departure To-day being added to the Mer. Diff. Yesterday, gives  $2^{\circ} 6'$ , the Mer. Diff. To-day.

With the Courfe and Mer. Diff. of lat. the Diff. of long. is found by Mercator to be 39 Miles. Or, with the Mid. lat. and Dep. the Diff. of long. is found by Mid. lat. failing 36 Miles West.

Yesterday's longitude  $7^{\circ} 44'W$ .

Longitude in — 8 20 W

Here the Diff. of long. found by Mid. lat. differs considerably from that found by Mercator's Sailing, but if the Mer. Parts were taken from a Table of Miles and Tenths it would agree nearer with Mid. lat. Sailing; but in all Cases where the Courfe is fo great, and the Difference of latitude is in Miles and Tenths, Middle latitude should be depended on.

To find the Bearings and Distance of Cape Finifterre,

|                 |            |                    |      |              |           |
|-----------------|------------|--------------------|------|--------------|-----------|
| Latitude in     | 44° 04' N. | Mer. Parts         | 2951 | Longitude in | 8° 20' W. |
| Cape's latitude | 42 52 N.   | Mer. Parts         | 2852 | Cape's long. | 9 14 W.   |
| Diff. latitude  | 72 = 1 12  | Mer. Diff. of lat. | 99   | Diff. long.  | 54        |

With the Mer. Diff. of lat. and Diff. of long. Cape Finifterre is found to bear S.  $28^{\circ} 37'$  W. and with that Bearing and the proper Diff. of lat. the Distance is found 82 Miles.

B b 2



| H. | K. | F. | Courfes.    | Winds.   | Lee-way. | REMARKS on Board, Saturday Apr. 28,<br>1792.                  |
|----|----|----|-------------|----------|----------|---------------------------------------------------------------|
| 2  | 4  | 5  | W. S. W.    | South.   |          | These 24 Hours moderate Gales, with<br>fmail Showers of Rain. |
| 4  | 4  | 5  |             |          |          |                                                               |
| 6  | 4  | 5  |             |          |          |                                                               |
| 8  | 4  |    |             |          |          |                                                               |
| 10 | 4  |    |             |          |          |                                                               |
| 12 | 4  |    |             |          |          |                                                               |
| 2  | 3  | 5  | S. W. by W. | S. by E. |          |                                                               |
| 4  | 3  | 5  |             |          |          |                                                               |
| 6  | 3  | 5  |             |          |          |                                                               |
| 8  | 3  |    |             |          |          |                                                               |
| 10 | 3  |    |             |          |          | A great Swell from the S. W. for<br>which I allow 6 Miles.    |
| 12 | 3  |    |             |          |          | Variation 1 Point West. per Azimuth.                          |

| Course.   | Dist. | Diff.<br>Lat. | Dep. | Lat. by<br>D. R. | Lat. by<br>Obf. | Mer.<br>Dist. | Diff.<br>Long. | Long. in. | Bearings and Distance.                      |
|-----------|-------|---------------|------|------------------|-----------------|---------------|----------------|-----------|---------------------------------------------|
| S 53 30 W | 84    | 50            | 67   | 42.44            |                 | 4.26          | 1.33           | 11.35     | Funchal S. 23° 15' W.<br>Distant 660 Miles. |

"In this Day's Work the Swell is considered as a Current, whose Drift in 24 Hours is 6 Miles, the allowance made for the Swell; and as it comes from the S. W. it heaves the Ship towards the N. E. and the Variation allowed upon it makes the last Course N. E. by N. as in the Traverse Table.

With the Diff. of lat. and Dep. the Course is found S.  $53^{\circ} 30' W.$  and the distance 84 Miles.

|                |          |                 |
|----------------|----------|-----------------|
| Diff. lat.     | 0° 50'S. | Mer. Parts.     |
| Latitude left  | 43 34 N. | 2910            |
| Lat. in        | 42 44    | 2841            |
| Sum of lat.    | 86 18    | Mer. Diff. lat. |
| Middle lat.    | 43 09    | 69              |
|                | 90 00    |                 |
| Com. Mid. lat. | 46 51    |                 |

| TRAVERSE TABLE. |            |      |      |           |      |
|-----------------|------------|------|------|-----------|------|
| Courses.        | Dist.      | N.   | S.   | E.        | W.   |
| S. W. by W.     | 58         |      | 32.2 |           | 48.2 |
| S. W.           | 32         |      | 32.6 |           | 22.6 |
| N. E. by N.     | 6          | 5.0  |      | 3.3       |      |
|                 |            | 5.0  | 54.8 | 3.3       | 70.8 |
|                 |            |      | 5.0  |           | 3.3  |
|                 | Diff. lat. | 49.8 |      | Dep. 67.5 |      |

The D. 67 being added to Yesterday's Mer. Dist. gives  $4^{\circ} 26'$  the Mer. Dist. this Day.

The Difference of longitude is found as before to be Yesterday's longitude

### Longitude in this Day

$1^{\circ} 33' W.$   
 $10 \quad 2 W.$   


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 $11 \quad 35 W.$

### To find the Bearings and Distance of Funchal.

|                  |            |                 |      |                   |            |
|------------------|------------|-----------------|------|-------------------|------------|
| Latitude in      | 42° 44' N. | Mer. Parts      | 2841 | Longitude in      | 11° 35' W. |
| Funchal's lat.   | 32 38 N.   | Mer. Parts      | 2073 | Funchal's long.   | 17 5 W.    |
| Diff. lat. 606 = | 10 6       | Mer. Diff. lat. | 768  | Diff. long. 330 = | 5 30       |

With the Mer, Diff. of lat. and Diff. long. Funchal is found to bear S.  $23^{\circ} 15' W.$  and with that Bearing taken as before, and the proper Diff. of lat. the Distance is 660 Miles.

To find the Bearing and Distance of the intended Port on Mercator's Chart.

Lay a Ruler across Mercator's Chart, in lat.  $42^{\circ} 44'$ , and set one Foot of the Compasses on the Meridian of London, and the other in Long.  $110^{\circ} 55' W.$  lay off that same Distance from the Meridian of London, by the Edge of the Ruler, and that will shew the Ship's Place. Then lay the ruler over the Ship's Place and Funchal, and take the nearest Distance between the ruler and the centre of the compass, slide one Foot along the side of the Ruler, and the other Foot will shew the Course to be S. S. W. Again, (keeping the Ruler as before) take from the gradual Parallel the Diff. of lat. between the Ship and Port ( $10^{\circ} 12'$ ) in your Compasses, and slide one Foot along the Ruler, holding both Points parallel to the N. and S. lines, till the other cuts the E. and W. lines, passing through the Ship's Place; the Distance between where the Point rested, by the Edge of the Ruler, and Funchal, being measured upon the graduated Parallel, gives nearly  $11^{\circ}$ , or 660 Miles for the Distance. In like Manner find the Bearing and Distance of any other Place from the Ship; or take the Distance between Funchal and the Ship in your Compasses, and lay it on the Meridian, nearly in the Parallels of the Ship and Funchal, and that will be the Dist. in Degrees or in leagues, if the Merid. is marked so.



| H.      | K.    | F.         | Courfes.            | Winds.                    | Lee-way.      | REMARKS on Board, Sunday, April 29th, 1792.   |                |           |                                                      |
|---------|-------|------------|---------------------|---------------------------|---------------|-----------------------------------------------|----------------|-----------|------------------------------------------------------|
| 2       | 4     | 5          | W. by N.            | S. W. by S.               |               | These 24 hours fresh gales and clear weather. |                |           |                                                      |
| 4       | 4     | 5          |                     |                           |               |                                               |                |           |                                                      |
| 6       | 4     | 5          |                     |                           |               |                                               |                |           |                                                      |
| 8       | 5     |            |                     |                           |               |                                               |                |           |                                                      |
| 10      | 5     |            |                     |                           |               |                                               |                |           |                                                      |
| 12      | 5     |            |                     |                           |               |                                               |                |           |                                                      |
| 2       | 5     | 5          | W. $\frac{1}{2}$ N. | S. S. W. $\frac{1}{2}$ W. | $\frac{1}{2}$ | Variation 1 point Westerly.                   |                |           |                                                      |
| 4       | 5     | 5          |                     |                           |               |                                               |                |           |                                                      |
| 6       | 5     | 5          |                     |                           |               |                                               |                |           |                                                      |
| 8       | 5     | 5          |                     |                           |               |                                               |                |           |                                                      |
| 10      | 5     | 5          |                     |                           |               |                                               |                |           |                                                      |
| 12      | 4     |            |                     |                           |               |                                               |                |           |                                                      |
| Courfe. | Diff. | Diff. lat. | Dep.                | Lat. by D. R.             | Lat. by Obs.  | Mer. Diff.                                    | Diff. of long. | Long. in. | Bearings and distance.                               |
| West.   | 120   |            | 120                 | 42. 44                    | 42. 30        | 6. 20                                         | 2. 43          | 14. 12    | Funchal, S. 13 <sup>OW</sup> .<br>Distant 608 miles. |

The variation being allowed on both the courfes, and the leeway upon the second, it will be found that the fhip has failed due West thefe laft 24 hours, and by fummung up the diftance her whole diftance is found to be 120 miles, which is alfo her departure; it is evident fhe has made no difference of latitude, therefore her latitude by account is the fame as yefterday.

As the fhip has failed upon a parallel with the Equator, her difference of longitude is found by parallel failing.

Yefterday's longitude  $2^{\circ} 43' W.$   
 $11 \quad 35 W.$   
 Longitude in by account  $14 \quad 18 W.$

The latitude by obfervation not agreeing with the latitude by account, and it being two days fince my laft obfervation, I correct as follows by Cafe II.

Laft Obf. lat.  $43^{\circ} 34'$  Mer. parts 2910 With with the Mer. diff. of lat. and diff. long.  
 Lat. in by acc.  $42 \quad 44$  Mer. parts 2841 by account, the courfe fince laft obf. is found to be S. 75 W. and the diftance 266 miles.

Mer. diff. lat. by account fince laft obf. 69

Long. in at laft obf.  $10^{\circ} 02' W.$

Ship's long. by account  $14 \quad 18 W.$

Diff. long. by acc. fince laft obf.  $4 \quad 16 W.$

Laft. obf. lat.  $43^{\circ} 34'$  Mer. parts 2910

This day's lat. by obf.  $43^{\circ} 30'$  Mer. parts 2822

Mer. diff. lat. by obf. fince laft obf. 88

With that diff. and the mer. diff. of lat. by obf. the true diff. of long. fince laft obfervation is found to be 250  $= 4^{\circ} 10' W.$

Long. in at laft obfervation  $10 \quad 1 W.$

Longitude in  $14 \quad 11 W.$

With the courfe fince laft obfervation S. 70° 30' W. and the proper diff. of lat. 64 miles, the departure (or Mer. diff.) fince laft obfervation is found 181 miles, equal to Mer. diff. at laft obf.  $3^{\circ} 01' W.$   
 $3 \quad 19 W.$

True Mer. diff. this day  $6 \quad 20 W.$

To find the bearings and diftance of Funchal in Madeira.

Latitude in  $42^{\circ} 30' N.$  Mer. parts 2822 Longitude in  $14^{\circ} 12' W.$   
 Funchal's lat.  $32 \quad 38 N.$  Mer. parts 2073 Funchal's long.  $17 \quad 5 W.$   
 Diff. lat. 592  $= 9 \quad 52$  Mer. diff. lat. 749 Diff. longitude  $2 \quad 53 = 173$

With the Mer. difference of latitude and difference of longitude the bearing of Funchal is found to be S. 13° W. and with that bearing taken as before, and the proper diff. of latitude the diftance is found 608 miles.

| H. | K. | F. | Courses.            | Winds.                      | Lee-way.      | REMARKS on Board, Monday, April 30th, 1792.   |
|----|----|----|---------------------|-----------------------------|---------------|-----------------------------------------------|
| 2  | 8  |    | S. S. W.            | N. W. by W.                 |               | Stiff gales, with showers of rain.            |
| 4  | 8  |    |                     |                             |               | From 2 P. M. fair weather and moderate gales. |
| 6  | 8  | 5  |                     |                             |               |                                               |
| 8  | 8  | 5  |                     |                             |               |                                               |
| 10 | 8  | 5  |                     |                             |               |                                               |
| 12 | 8  | 5  |                     |                             |               |                                               |
| 2  | 9  | 0  | S. $\frac{3}{4}$ E. | S. W by W. $\frac{1}{4}$ W. | $\frac{1}{8}$ |                                               |
| 4  | 6  | 0  |                     |                             |               |                                               |
| 6  | 5  | 5  |                     |                             |               |                                               |
| 8  | 5  | 5  |                     |                             |               |                                               |
| 10 | 5  |    |                     |                             |               |                                               |
| 12 | 5  |    |                     |                             |               |                                               |

Variation 1 point Westerly per Amplit.

| Cours. | Diff. | Lat. | Dep. | Lat by D. R. | Lat. by Obs. | Mer. Dist. | Diff. Long. | Long. in. | Bearings & Distance.                    |
|--------|-------|------|------|--------------|--------------|------------|-------------|-----------|-----------------------------------------|
| South. | 170   | 170  |      | 39. 46       | 39. 40       | 6. 20      |             | 14. 12    | Funchal S 18° 16' W. Distant 444 Miles. |

TRAVERSE TABLE.

Yesterday's lat.  $42^{\circ} 30' N.$   
 Diff. lat.  $2 44 S.$   
 Lat in by Account  $39 46 N.$

| Courses.                  | Diff.      | N. | S.    | E.   | W.   |
|---------------------------|------------|----|-------|------|------|
| S. by W.                  | 118        |    | 115.7 |      | 23.0 |
| S. S. E. $\frac{1}{4}$ E. | 54         |    | 48.8  | 23.1 |      |
|                           | Diff. lat. |    | 164.5 | 23.1 | 23.0 |
|                           |            |    |       | 23.0 |      |
|                           |            |    |       | 0.1  | Dep. |

Proper allowances being made for variation and lee-way, it appears from the Traverse Table that the ship has sailed due South 164 $\frac{1}{2}$  miles, and as she made no departure, her longitude in and mer. dist. is the same as Yesterday; but as by observation the ship is found to be in lat.  $39^{\circ} 40' N.$  it is plain she has got 6 miles a-head of her reckoning, which 6 miles being added to the distance by D. R. gives the true distance and difference of latitude as above.

## To find the Bearings and Distance of Funchal.

|                |                     |                 |      |                   |                     |
|----------------|---------------------|-----------------|------|-------------------|---------------------|
| Latitude in    | $39^{\circ} 40' N.$ | Mer. Parts      | 2597 | Longitude in      | $14^{\circ} 12' W.$ |
| Funchal's Lat. | $32 38 N.$          | Mer. Parts      | 2073 | Funchal's long.   | $17 5 W.$           |
| Diff. lat. 422 | 7 2                 | Mer. Diff. lat. | 524  | Diff. long. 173 = | 2 53                |

With the mer. diff. lat. 524, and the diff. of long. in miles 173, the direct course to Funchal is found S.  $18^{\circ} 16'$ , or  $18^{\circ} W.$  and with that course and the proper diff. of lat. 422, the distance is found to be 444 miles.

Now a parallel of lat. through  $39^{\circ} 40'$  on the variation chart, cuts the variation lines in  $11^{\circ} 15'$  in longitude  $14^{\circ} 0' W.$  which confirms the longitude by account.

The variation charts might be of great use were they drawn upon a large scale, and the lines of variations well laid down, but as the variation in most places is continually altering, it renders them in a few years useless; I would therefore advise the Mariner to trust more to his reckoning and lunar observations, since the theory of the variation is not yet known.

| H. | K. | F. | Courses.                  | Winds.                   | Lee-way.      | REMARKS on board, Tuesday, May 11, 1793.                  |
|----|----|----|---------------------------|--------------------------|---------------|-----------------------------------------------------------|
| 2  | 8  |    | S. S. W. $\frac{1}{4}$ W. | W. by N. $\frac{1}{4}$ W | $\frac{1}{2}$ | Fresh gales and clear weather.                            |
| 4  | 8  |    |                           |                          |               |                                                           |
| 6  | 8  | 5  |                           |                          |               |                                                           |
| 8  | 8  | 5  |                           |                          |               |                                                           |
| 10 | 8  |    |                           |                          |               | Boatwain and people employed mending the mizen stay-sail. |
| 12 | 8  | 5  |                           |                          |               |                                                           |
| 2  | 8  | 4  |                           |                          |               |                                                           |
| 4  | 8  | 4  |                           |                          |               |                                                           |
| 6  | 8  | 6  |                           |                          |               |                                                           |
| 8  | 8  | 6  |                           |                          |               |                                                           |
| 10 | 8  | 5  |                           |                          |               |                                                           |
| 12 | 8  |    |                           |                          |               | Variation $\frac{1}{2}$ point Wly. per azimuth.           |

| Cours.                    | Dist. | Diff. Lat. | Dep. | Lat. by D. R. | Lat. by Obs. | Mer. Diff. | Diff. Long. | Long. in. | Bearings and Dist.                                |
|---------------------------|-------|------------|------|---------------|--------------|------------|-------------|-----------|---------------------------------------------------|
| S. by W. $\frac{1}{2}$ W. | 192   | 184        | 56   | 36. 29        | 36. 36       | 7. 17      | 1. 11       | 15. 23    | Funchal S. $19^{\circ} 33'$ W. Distant 253 Miles. |

By examining the Log-board it appears that the ship has sailed S. S. W.  $\frac{1}{2}$  W. 200 Miles.

Latitude left  $39^{\circ} 40' N$   
Diff. latitude 3 11 S.

Lat. in by account 36 29 N.

| TRAVERSE TABLE.           |       |            |        |      |        |
|---------------------------|-------|------------|--------|------|--------|
| Courses.                  | Diff. | N.         | S.     | E.   | W.     |
| S. by W. $\frac{1}{2}$ W. | 200   | Diff. lat. | 191. 0 | Dep. | 15. 23 |

The latitude by observation not agreeing with the latitude by D. R. I correct as follows by Case I.

With the course one point and a half, and the diff. of lat. by obs. 184, the dist. is found to be 192 miles, and the dep. 56, which being added to the mer. dist. yesterday  $6^{\circ} 21' W$ , gives the mer. dist. to-day  $7^{\circ} 17' W$ .

|                      |                                     |                 |      |
|----------------------|-------------------------------------|-----------------|------|
| Yesterday's latitude | $39^{\circ} 40' N$ .                | Mer. parts      | 2597 |
| This day's obs. lat. | $36^{\circ} 36' N$ .                | Mer. parts      | 2363 |
| Sum of latitudes     | —                                   | Mer. diff. lat. | 234  |
| Middle latitude      | $38^{\circ} 8'$<br>$90^{\circ} 00'$ |                 |      |
| Comp. mid. lat.      | $51^{\circ} 52'$                    |                 |      |

The diff. of long. is found by Mercator or mid. lat.  
Yesterday's long.  $1^{\circ} 11' W$ .  
Long. in this day 14 12 W.  
Long. in this day 15 23

To find the bearings and distance of Funchal.

|                  |                      |                 |      |                                    |                      |
|------------------|----------------------|-----------------|------|------------------------------------|----------------------|
| Latitude in      | $36^{\circ} 36' N$ . | Mer. parts      | 2363 | Longitude in                       | $15^{\circ} 21' W$ . |
| Funchal's lat.   | $32^{\circ} 38' N$ . | Mer. Parts      | 2073 | Funchal's long                     | $17^{\circ} 05' W$ . |
| Diff. lat. 238 = | 3 58                 | Mer. diff. lat. | 290  | Diff. long. $103' = 1^{\circ} 43'$ |                      |

With the mer. diff. of lat. and the diff. of long. the bearings of Funchal is found, and with that bearing and the proper diff. of lat. the distance is found 253 miles.



| h. | K. | F. | Courfes.                  | Winds.                    | Lee-way.      | REMARKS on Board, Wednesday May 24, 1792.             | T. | M. | H. |
|----|----|----|---------------------------|---------------------------|---------------|-------------------------------------------------------|----|----|----|
| 2  |    | 3  | W. by S. $\frac{1}{2}$ W. | S. by W. $\frac{1}{2}$ W. | $\frac{1}{2}$ | These 24 hours moderate weather with rain.            |    |    |    |
| 4  | 4  | 5  |                           |                           |               |                                                       |    |    |    |
| 6  | 4  | 7  | W. S. W. $\frac{1}{2}$ W. | S. $\frac{1}{2}$ W.       | $\frac{1}{2}$ |                                                       |    |    |    |
| 8  | 5  |    |                           |                           |               |                                                       |    |    |    |
| 10 | 5  | 2  |                           |                           |               |                                                       |    |    |    |
| 12 | 5  | 3  |                           |                           |               |                                                       |    |    |    |
| 2  | 5  | 5  | W. S. W.                  | South.                    | $\frac{1}{2}$ |                                                       |    |    |    |
| 4  | 5  | 5  |                           |                           |               |                                                       |    |    |    |
| 6  | 5  | 4  |                           |                           |               |                                                       |    |    |    |
| 8  | 5  | 1  |                           |                           | $\frac{1}{2}$ |                                                       |    |    |    |
| 10 | 5  |    | S. W. by W.               | S. by E.                  |               |                                                       |    |    |    |
| 12 | 4  | 5  |                           |                           |               | Varia. $\frac{1}{2}$ P. M. per equal alt. of the sun. |    |    |    |

| Courfe.   | Diff. | Lat. by | Lat. by | Mer. | Diff. of | Long. | Long. in | Bearings and Dist.                        |
|-----------|-------|---------|---------|------|----------|-------|----------|-------------------------------------------|
| Diff.     | Lat.  | Dep.    | D.      | R.   | Obs.     | Diff. | Long.    |                                           |
| S. 65° W. | 119   | 50      | 108     | 35   | 53       | 35    | 46       | Funchal S. 70° 44' E. Distance 190 miles. |

|                                                                                           |                          |    |  |                              |          |                 |            |      |
|-------------------------------------------------------------------------------------------|--------------------------|----|--|------------------------------|----------|-----------------|------------|------|
| With the diff. of lat. and dep. the course found S. 68° 10' W. and the dist. 118.6 Miles. |                          |    |  | TRAVERSE TABLE.              |          |                 |            |      |
| Yesterday's lat.                                                                          | 36° 36' N.               |    |  | Courfes.                     | Diff. N. | S.              | E.         | W.   |
| Diff. of lat.                                                                             | 44 8.                    |    |  |                              |          |                 |            |      |
| Lat. by acc.                                                                              | 35° 52' N.               |    |  | W. by S. $\frac{1}{2}$ W.    | 27       | 4.0             |            | 26.0 |
|                                                                                           |                          |    |  | W. S. W. $\frac{1}{2}$ W.    | 31       | 10.4            |            | 29.8 |
| Yesterday's lat.                                                                          | 36° 36' N. M. parts 2363 |    |  | S. W. by W. $\frac{1}{2}$ W. | 43       | 18.4            |            | 38.9 |
| Obf. lat.                                                                                 | 35° 46' N. M. parts 2301 |    |  | S. W. $\frac{1}{2}$ W.       | 19       | 11.3            |            | 15.3 |
| Diff. lat. by obf.                                                                        | 50 M. diff. lat.         | 62 |  |                              |          | Diff. lat. 44.1 | Dep. 118.6 |      |

|           |    |    |  |  |  |  |  |  |
|-----------|----|----|--|--|--|--|--|--|
| Sum lats. | 72 | 22 |  |  |  |  |  |  |
|-----------|----|----|--|--|--|--|--|--|

Middle latitude 36 11  
90 00

The latitude by observation not agreeing with the latitude by account, I correct as follows, by Case III.

Comp. mid. lat. 53 49

With the proper diff. of lat. by obf. 50' and the distance 118.6 the true course is found 5° 04', and the departure 108 miles nearly.

The departure 108 being added to the mer. diff. yesterday, gives 9° 5' W. the mer. diff. to-day.

With the comp. of mid. lat. and dep. or with the course and mer. diff. of lat. 62' the diff. of long. is found by mid. lat. or Mercator's failing to be 133 miles = 2° 13' W.

Yesterday's longitude 15 23' W.

Longitude in — 17 36 W.

To find the bearings and distance of Funchal in Madeira.

|                            |            |                    |      |                              |            |
|----------------------------|------------|--------------------|------|------------------------------|------------|
| Latitude in Funchal's lat. | 35° 46' N. | Mer. parts         | 2391 | Longitude in Funchal's long. | 17° 36' W. |
|                            | 32 38 N.   | Mer. parts         | 2073 |                              | 17 05 W.   |
| Diff. latitude             | 3 8        | Mer. diff. of lat. | 228  | Diff. long.                  | 31         |

With the mer. diff. of lat. 228, and the diff. of long. 31', Funchal is found to bear S. 7° 04' E. and with that bearing (taken as before) and the proper diff. of latitude, the distance is found 190 miles.

| H. | K. | F. | Courses.                  | Winds.                       | Lee-way.      | REMARKS on board, Thursday, May 1792.            |
|----|----|----|---------------------------|------------------------------|---------------|--------------------------------------------------|
| 2  | 6  | 6  | S. by E. $\frac{1}{2}$ E. | S. W. $\frac{1}{2}$ W.       | $\frac{1}{2}$ | These 24 hours moderate gales and clear weather. |
| 4  | 5  | 8  |                           |                              |               |                                                  |
| 9  | 5  | 8  |                           |                              |               |                                                  |
| 8  | 5  | 8  |                           |                              |               |                                                  |
| 10 | 5  |    | S. S. E.                  | S. W.                        | $\frac{1}{2}$ |                                                  |
| 12 | 5  | 2  |                           |                              |               |                                                  |
| 2  | 5  | 3  |                           |                              |               |                                                  |
| 4  | 5  | 5  | S. S. E. $\frac{1}{2}$ E. | S. W. by S. $\frac{1}{2}$ W. | $\frac{1}{2}$ |                                                  |
| 6  | 5  | 5  |                           |                              |               |                                                  |
| 8  | 5  | 5  |                           |                              |               |                                                  |
| 10 | 5  | 6  | S. E. by E.               | S. W. by S.                  | $\frac{1}{2}$ |                                                  |
| 12 | 5  | 4  |                           |                              |               | Variation $\frac{1}{2}$ point Westerly.          |

| Courfe.                | Diff. | Lat. by | Lat. by | Mer.  | Diff. | Long. | Long. in | Bearings and distance                                     |
|------------------------|-------|---------|---------|-------|-------|-------|----------|-----------------------------------------------------------|
|                        |       | Lat.    | Dep.    | D. R. | Obs.  |       |          |                                                           |
| S. $35^{\circ} 30' E.$ | 135   | 110     | 78      | 34 01 | 33 56 | 7 47  | 1 35     | 16 01 Funchal S. $34^{\circ} 15' W.$<br>Distant 94 Miles. |

With the diff. of lat. and dep. the course is found S.  $37^{\circ} 48' E.$  and the distance 133 miles.

Yesterday's lat.  $35^{\circ} 46' N.$   
Diff. of lat.  $1^{\circ} 45' S.$

Lat. by account  $34^{\circ} 01' N.$

Obs. lat.  $33^{\circ} 56' N.$  M. parts 2167  
Yesterday's lat.  $35^{\circ} 46' N.$  M. parts 2301

Prop. diff. lat. obs.  $1^{\circ} 50'$  M. dist. 134

Sum of lat.  $69^{\circ} 42'$

Middle latitude  $34^{\circ} 51'$   
 $90^{\circ} 00'$

Comp. mid. lat.  $55^{\circ} 09'$

| Courses                      | Dist. | N. | S.                    | E.   | W.   |
|------------------------------|-------|----|-----------------------|------|------|
| S. S. E. $\frac{1}{2}$ E.    | 48    |    | 41.2                  | 14.7 |      |
| S. E. by S. $\frac{1}{2}$ E. | 31    |    | 24.9                  | 18.5 |      |
| S. E. by S. $\frac{1}{2}$ E. | 33    |    | 24.4                  | 22.3 |      |
| S. E. $\frac{1}{2}$ E.       | 22    |    | 14.8                  | 16.3 |      |
|                              |       |    | Diff. lat. $105.3 S.$ | 18.7 | Dep. |

The latitude by obs. differing from the latitude by account, I correct as follows, by Case II.

With the diff. of lat. 110 and the dist. 133, the dep. is found to be 75, which being added to the former dep. 82, gives 157, half this sum is the true dep. 78 miles; With the diff. of lat. 110 and the dep. 78, the true course is found S.  $35^{\circ} 20' E.$  and the dist. 135 miles.

The dep. 78 being subtracted from the mer. dist. yesterday, gives  $7^{\circ} 47' W.$  the mer. dist. this day.

The diff. of long. is found by Mercator, or middle latitude sailing, to be  $1^{\circ} 35' E.$   
Yesterday's longitude  $17^{\circ} 36' W.$

Longitude in  $16^{\circ} 01' W.$

To find the bearings and distance of Funchal in Madeira.

|                            |                     |                    |      |                              |                     |
|----------------------------|---------------------|--------------------|------|------------------------------|---------------------|
| Latitude in Funchal's lat. | $33^{\circ} 56' N.$ | Mer. parts         | 2167 | Longitude in Funchal's long. | $16^{\circ} 01' W.$ |
|                            | $32^{\circ} 38' N.$ | Mer. parts         | 2073 |                              | $17^{\circ} 05' W.$ |
| Diff. lat.                 | $1^{\circ} 18'$     | Mer. diff. of lat. | 94   | Diff. of long.               | $1^{\circ} 04'$     |

With the meridional difference of latitude and difference of longitude, the direct course to Funchal is S.  $34^{\circ} 15' W.$  and with that course and the proper difference of latitude, the dist. is found 94 miles.

## 201

The Variation allowed upon the Course, and also upon the bearing of the land taken at ten o'clock, being put into a traverse table, and the distance run upon each course, with the distance you are from the land, will give the distance and difference of latitude and departure as above; with the complement of the middle latitude and departure, the difference of longitude is  $63 = 1^{\circ} 3'$ , which added to  $16^{\circ} 1'$  the longitude in yesterday at noon, gives  $17^{\circ} 4'$ , the longitude in by account; and as it agrees with the longitude of Funchal in the table, I conclude that my reckoning is just, and Funchal well laid down. The ship's place in the preceding Journal is pricked off, and the bearing and distance at noon are also found by the Chart, in order to shew the young Navigator the method, and may be done with a black lead pencil, which he may either let stand or rub out when he pleases.

| H. | K. | F. | Courfes. | Winds. | Lee-way. | REMARKS ON BOARD, Monday, May 27, 1792.                                                                           |
|----|----|----|----------|--------|----------|-------------------------------------------------------------------------------------------------------------------|
| 2  |    |    |          | N. E.  |          | Fresh breezes and clear. At 4 P. M. unmoored ship and hove in to $\frac{1}{4}$ of a cable on the best bower.      |
| 4  |    |    |          |        |          |                                                                                                                   |
| 6  |    |    |          |        |          |                                                                                                                   |
| 8  |    |    |          |        |          |                                                                                                                   |
| 10 |    |    |          |        |          |                                                                                                                   |
| 12 |    |    |          |        |          | Light breezes and clear.                                                                                          |
| 2  |    |    |          |        |          | At 6 A. M. weighed from Funchal Road and made fail. Lat. obs. $32^{\circ} 16' N$ . Variation $18^{\circ} 30' W$ . |
| 4  |    |    |          |        |          |                                                                                                                   |
| 6  |    |    |          |        |          |                                                                                                                   |
| 8  |    |    |          |        |          |                                                                                                                   |
| 10 |    |    |          |        |          | Ditto W. at noon the Southernmost Deserta N. W. 4 or 5 leagues.                                                   |
| 12 |    |    |          |        |          |                                                                                                                   |

| Courfe. | Diff. | Lat. by | Lat. by | Mer.                 | Diff. of | Long. | Bearings and distance.                |
|---------|-------|---------|---------|----------------------|----------|-------|---------------------------------------|
| Diff.   | Lat.  | Dep.    | D. R.   | Obs.                 | Dist.    | Long. |                                       |
|         |       |         |         | $32^{\circ} 10' N$ . |          |       | Southernmost Deserta N. W. 5 leagues. |

| TRAVERSE TABLE. |  |  |  |  |  |
|-----------------|--|--|--|--|--|
|                 |  |  |  |  |  |



| H.                   | K.    | F.   | Courses.                  | Winds.        | Lee-way.     | REMARKS ON BOARD, Tuesday, May 27th, 1792. |                |                                  |                                                    |
|----------------------|-------|------|---------------------------|---------------|--------------|--------------------------------------------|----------------|----------------------------------|----------------------------------------------------|
| 2                    | 6     | 2    | S. S. W.                  | N. N. E.      |              | Light breezes and clear.                   |                | Variation per                    |                                                    |
| 4                    | 3     | 2    | S. S. W. $\frac{1}{2}$ W. |               |              | amplitude $18^{\circ} 30' W.$              |                |                                  |                                                    |
| 6                    | 3     | 2    |                           |               |              |                                            |                |                                  |                                                    |
| 8                    | 2     |      |                           |               |              |                                            |                |                                  |                                                    |
| 10                   | 2     |      |                           |               |              |                                            |                |                                  |                                                    |
| 12                   |       |      | Calm.                     |               |              | Made and shortened sail occasionally.      |                |                                  |                                                    |
| 2                    | 4     | 4    | S. S. W. $\frac{1}{2}$ W. | W. N. W.      |              |                                            |                |                                  |                                                    |
| 4                    | 5     | 4    |                           |               |              |                                            |                |                                  |                                                    |
| 6                    | 6     |      |                           |               |              |                                            |                |                                  |                                                    |
| 8                    | 6     | 3    |                           |               |              |                                            |                |                                  |                                                    |
| 10                   | 5     | 6    |                           | N. W.         |              | Fresh breezes and clear.                   |                | Set studding sails               |                                                    |
| 12                   | 4     |      |                           |               |              |                                            |                | Lat. by obs. $30^{\circ} 31' N.$ |                                                    |
| Courfe.              | Diff. | lat. | Dep                       | Lat. by D. R. | Lat. by Obs. | Mer. Dist.                                 | Diff. of long. | Long. in.                        | Bearings and distance.                             |
| S $1^{\circ} 30' E.$ | 100   | 99   | 2.7                       | $30. 31' N.$  | $30. 31' N.$ | 2.7                                        | 3 miles E.     | $16^{\circ} 22' W.$              | Salvages, S. $34^{\circ} 42' E.$ Distant 28 miles. |

By taking my departure from the southernmost Desert, which is in lat.  $32. 18 N.$  long.  $16. 25 E.$  and bearing from me yesterday at noon N. W. 5 leagues; I find the course answering to that bearing, corrected for variation, to be S.  $63^{\circ} E.$  distant 15 miles; which I have set down in the Traverse Table as a course.

| TRAVERSE TABLE.           |                    |            |      |      |      |     |  |
|---------------------------|--------------------|------------|------|------|------|-----|--|
| Courfe per log.           | Courses corrected. | Diff.      | N.   | S.   | E.   | W.  |  |
| S. E.                     | S. $63^{\circ} E.$ | 15         |      | 6.8  | 13.4 |     |  |
| S. S. W.                  | S. $4^{\circ} W.$  | 12         |      | 12.6 |      | 0.8 |  |
| S. S. W. $\frac{1}{2}$ W. | S. $7^{\circ} W.$  | 81         |      | 80.4 |      | 9.9 |  |
|                           |                    | Diff. Lat. | 99.2 | 13.4 | 10.7 |     |  |
|                           |                    | Dep.       | 2.7  |      |      |     |  |

With the difference of latitude and departure the course is found to be S.  $1^{\circ} 30' E.$  distant 100 miles.

With the com. mid. lat. the diff. of long. is found to be 3 miles.

Diff. lat.  $1^{\circ} 39' S.$

Lat. left  $32^{\circ} 10' N.$  Mer. pts. 2040

Lat. in  $30^{\circ} 31' N.$  Mer. pts. 1924

Sum. lat.  $62^{\circ} 41' N.$  Mer. dist. 116 Lat. Salvages  $30^{\circ} 8' N.$  Mer. pts. 1898 Long.  $16^{\circ} 25' E.$  Lat. in  $30^{\circ} 31' N.$  Mer. pts. 1924 Long. in  $16^{\circ} 25' E.$

Mid. lat.  $31^{\circ} 20' N.$

23

26

Co. m. lat.  $58^{\circ} 40' N.$

With the mer. diff. lat. and diff. long. the Salvages is found to bear S.  $34^{\circ} 42' E.$  distant 28 miles.

| H.                 | K.    | F.   | Courses. | Winds.           | Leg-way.        | REMARKS on Board, Wednesday,<br>May 28, 1792.                                   |                |           |                                                                |
|--------------------|-------|------|----------|------------------|-----------------|---------------------------------------------------------------------------------|----------------|-----------|----------------------------------------------------------------|
| 2                  | 6     | 4    | South.   | West.            |                 | Fresh breezes and clear. All sails<br>set.                                      |                |           |                                                                |
| 4                  | 6     | 2    |          |                  |                 |                                                                                 |                |           |                                                                |
| 6                  | 5     | 0    |          |                  |                 |                                                                                 |                |           |                                                                |
| 8                  | 4     | 2    |          |                  |                 | Variation $18^{\circ}$ west.                                                    |                |           |                                                                |
| 10                 | 6     | 3    |          |                  |                 |                                                                                 |                |           |                                                                |
| 12                 | 5     | 4    |          |                  |                 |                                                                                 |                |           |                                                                |
| 2                  | 5     | 4    | S. by W. | W. by N.         |                 | Fresh breezes and pleasant weather.<br>Two sail in sight.                       |                |           |                                                                |
| 4                  | 5     |      |          |                  |                 |                                                                                 |                |           |                                                                |
| 6                  | 3     |      |          |                  |                 |                                                                                 |                |           |                                                                |
| 8                  | 3     | 1    |          |                  |                 |                                                                                 |                |           |                                                                |
| 10                 | 2     | 4    |          |                  |                 | Light breezes and cloudy. In stud-<br>ding sails. Lat. obs. $28^{\circ} 48' N.$ |                |           |                                                                |
| 12                 | 2     |      |          | W. by S.         |                 |                                                                                 |                |           |                                                                |
| Courfe.            | Diff. | Lat. | Dep.     | Lat. by<br>D. R. | Lat. by<br>Obs. | Mer.<br>Dist.                                                                   | Diff.<br>Long. | Long. in. | Bearings and distance.                                         |
| S. $14^{\circ} E.$ | 107   | 104  | 26       | $28.47 N$        | $28.48 N$       | 29 E.                                                                           | 29 mile        | 15. 53 W. | Sta. Cruz, Teneriffe, S.<br>$47^{\circ} 23' W.$ Dist. 30 miles |

Courses being corrected for variation, I find by the Traverse Table, the direct course of the ship to be S.  $14^{\circ} E.$  and the distance 107 miles.

| TRAVERSE TABLE.                |                    |       |    |      |      |    |
|--------------------------------|--------------------|-------|----|------|------|----|
| Courses per log.               | Courses corrected. | Diff. | N. | S.   | E.   | W. |
| South.                         | S. $18^{\circ} E.$ | 67    |    | 63.7 | 20.7 |    |
| S. by W.                       | S. $7^{\circ} E.$  | 41    |    | 40.7 | 3.0  |    |
| Diff. lat. $104.4$ $25.7$ Dep. |                    |       |    |      |      |    |

Diff. of lat.  $1^{\circ} 44' S.$   
Lat. left  $30^{\circ} 31' N.$  Mer. pts. 1924

Lat. in  $28^{\circ} 47' N.$  Mer. pts. 1805  
Mer. diff. 119

Sum of lat. 59 18

Lat. Teneriffe  $28.27 N.$  —  $1782$  Long. Tene.  $16^{\circ} 18' W.$

Lat. in —  $28.47 N.$  —  $1805$  Long. in  $15^{\circ} 53' W.$

Mid. lat. 29 39

Diff. lat. 20 Mer. p. 27 Diff. long. 25

Co. mid. lat. 60 21

With the comp. of mid. lat. the diff. of long. is found to be 29 miles.

With the mer. diff. lat. and diff. long. by Mercator, the Bay of Santa Cruz in Teneriffe is S.  $47.23 W.$  dist. 30 miles.

As this Journal is only intended to show the learner how to keep his reckoning at sea, the true variation is not particularly attended to.

| H. | K. | F. | Courses. | Winds. | Lee-way. | REMARKS on Board, Thursday May 29, 1792.           |
|----|----|----|----------|--------|----------|----------------------------------------------------|
| 2  | 3  | 4  | S. S. E. | S. W.  | 1        | point. Fresh breezes and cloudy.                   |
| 4  | 3  |    |          |        |          |                                                    |
| 6  | 2  | 4  |          |        |          | Handed top-gallant sails and in first reef top     |
| 8  | 3  |    |          |        |          | sails. At 6 the Peak of Teneriffe bore by          |
| 10 | 3  |    |          |        |          | compass W. S. W.                                   |
| 12 | 2  | 4  | W. N. W. | Ditto. | 1        | Fresh breezes and clear. Variation $18^{\circ}$ W. |
| 2  | 2  | 4  |          |        |          |                                                    |
| 4  | 2  |    |          |        |          | Set top-gallant sails. Hazy with rain. No          |
| 6  | 2  |    |          |        |          | land in sight. No observation.                     |
| 8  | 3  |    |          |        |          | Light breezes and clear.                           |
| 10 | 2  | 4  | S. S. E. | Ditto. | 1        | At noon made Teneriffe, bearing W. by N.           |
| 12 | 2  | 4  |          |        |          | dist. 12 leagues.                                  |

| Cours.             | Diff. | Lat. | Dep. | Lat. by D. R. | Lat. by Obf. | Mer. Dist. | Diff. Long. | Long. in | Bearings and dist.                                           |
|--------------------|-------|------|------|---------------|--------------|------------|-------------|----------|--------------------------------------------------------------|
| S. $25^{\circ}$ E. | 20    | 18   | 8    | 28.30         |              | 37 E.      | 10m. E.     | 15.43 W. | Sta. Cruz, Teneriffe, S. $84^{\circ} 26'$ W. Dist. 31 miles. |

The courses being corrected for one point leeway, and  $18^{\circ}$  W. variation all these 24 hours, I find by the Traverse Table the direct course of the ship to be S.  $25^{\circ}$  E. distance 20 miles.

|                |                    |
|----------------|--------------------|
| Diff. of lat.  | $0^{\circ} 18'$ S. |
| Lat. left      | — 28 48 N.         |
| Lat. in        | — 28 30 N.         |
| Sum lats.      | — 57 18            |
| Mid. lat.      | — 28 39            |
| Com. mid. lat. | 61 21              |

TRAVERSE TABLE.

| Courses per log. | Courses corrected. | Dist. | N.         | S.   | E.   | W.   |
|------------------|--------------------|-------|------------|------|------|------|
| S. S. E.         | S. $52^{\circ}$ E. | 30    |            | 18.5 | 23.6 |      |
| W. N. W.         | N. $74^{\circ}$ W. | 24    | 6.6        |      |      | 23.1 |
| S. S. E.         | S. $52^{\circ}$ E. | 10    |            | 6.2  | 7.9  |      |
|                  |                    |       | 6.6        | 24.7 | 31.5 | 23.1 |
|                  |                    |       |            | 6.6  | 23.1 |      |
|                  |                    |       | Diff. lat. | 18.1 | 8.4  | Dep. |

With the comp. of mid. lat. the diff. of long. is found to be 10 miles; and the bearing and distance of Santa Cruz by mid. lat. is found to be S.  $84^{\circ} 26'$  W. dist. 31 miles.

| H. | K. | F. | Courses. | Winds.    | Lee-way. | REMARKS on board, Friday, May 30th, 1792. |
|----|----|----|----------|-----------|----------|-------------------------------------------|
| 2  | 5  |    | W. by N. | S. S. E.  |          | Light breezes and clear. Made all sail.   |
| 4  | 5  | 4  |          |           |          |                                           |
| 6  | 6  |    |          |           |          | At 5 the east end of Teneriffe N. W.      |
| 8  |    |    |          |           |          | 4 miles; at 7 anchored in 9 fathom        |
| 10 |    |    |          |           |          | in Santa Cruz Road, the town of           |
| 12 |    |    |          | Variable. |          | Santa Cruz W. by N. $\frac{1}{2}$ a mile. |
| 2  |    |    |          |           |          | Variation $17^{\circ} 30'$ west.          |
| 4  |    |    |          | West.     |          | At 8 A. M. hoisted out the boats and      |
| 6  |    |    |          |           |          | went on shore to wait on the Gov.         |
| 8  |    |    |          |           |          | Moored ship with the small bower to       |
| 10 |    |    |          | Calm.     |          | the S. W. in 19 fathom and stream         |
| 12 |    |    |          | South.    |          | anchor to the N. E. in 10 fathom.         |

| Cours.             | Diff. | Lat. | Dep. | Lat. by D. R. | Lat. by Obf. | Mer. Dist. | Diff. Long. | Long. in            | Bearings and Dist.                     |
|--------------------|-------|------|------|---------------|--------------|------------|-------------|---------------------|----------------------------------------|
| S. $84^{\circ}$ W. | 33    | 3    | 33   | 28.27 N       |              | 4mi. E.    | 37m. W      | $16^{\circ} 20'$ W. | At anchor in Santa Cruz Rd, Teneriffe. |

The courses being corrected for  $17^{\circ} 30'$  W. variation, I find by the Traverse Table the true course to be S.  $84^{\circ}$  W. dist. 33 miles.

|                |                   |
|----------------|-------------------|
| Diff. lat.     | $0^{\circ} 3'$ S. |
| Lat. left      | — 28 30 N.        |
| Lat.           | — 28 27           |
| Com. mid. lat. | 61 33             |

TRAVERSE TABLE.

| Cours. per log. | Courses corrected. | Dist. | N.         | S.  | E.   | W.   |
|-----------------|--------------------|-------|------------|-----|------|------|
| W. by N.        | S. $84^{\circ}$ W. | 33    |            | 3.4 |      | 32.8 |
|                 |                    |       | Diff. lat. | 3.4 | Dep. | 32.8 |

With the com. of mid. lat. the diff. of long. is 37 miles.



# An ABSTRACT of the foregoing JOURNAL.

| Days.      | Months.  | 1792.                                                                                             | Courses.        | Dist. | Lat. by D. R. | Lat. by Obs. | Long. in  | Bearings and Distances at Noon.           |
|------------|----------|---------------------------------------------------------------------------------------------------|-----------------|-------|---------------|--------------|-----------|-------------------------------------------|
| Sunday,    | April 22 |                                                                                                   | S. 26° 30' W.   | 96    | 48° 21' N.    |              | 6° 28' W. | Funchal, S. 27° W. distant 1058 miles.    |
| Monday,    | April 23 |                                                                                                   | S. 30° W.       | 108   | 46. 48 N.     |              | 7. 47 W.  | Funchal, S. 26. 39 W. distant 951 miles.  |
| Tuesday,   | April 24 |                                                                                                   | S. 8. 30 W.     | 97    | 45. 12 N.     | 45. 23 N.    | 8. 1 W.   | Funchal, S. 28. 47 W. distant 873 miles.  |
| Wednesday, | April 25 |                                                                                                   | S. 9° E.        | 76    | 44. 8 N.      |              | 7. 44 W.  | Funchal, S. 32. 24 W. distant 817 miles.  |
| Thursday,  | April 26 |                                                                                                   | S. 81. 20 W.    | 25    | 44. 4 N.      |              | 8. 20 W.  | Funchal, S. 30. 53 W. distant 799 miles.  |
| Friday,    | April 27 |                                                                                                   | S. 80 W.        | 84    | 43. 49 N.     | 43. 34 N.    | 10. 2 W.  | Funchal, S. 26. 49 W. distant 735 miles.  |
| Saturday,  | April 28 |                                                                                                   | S. 53. 30 W.    | 84    | 42. 44 N.     |              | 11. 35 W. | Funchal, S. 23. 15 W. distant 660 miles.  |
| Sunday,    | April 29 |                                                                                                   | West.           | 120   | 42. 44 N.     | 42. 30 N.    | 14. 12 W. | Funchal, S. 13. W. distant 608 miles.     |
| Monday,    | April 30 |                                                                                                   | S.              | 170   | 39. 47 N.     | 39. 30 N.    | 14. 12 W. | Funchal, S. 18. 16 W. distant 444 miles.  |
| Tuesday,   | May 1    |                                                                                                   | S. by W. 1/2 W. | 192   | 39. 29 N.     | 39. 36 N.    | 15. 23 W. | Funchal, S. 19. 33 W. distant 253 miles.  |
| Wednesday, | May 2    |                                                                                                   | S. 65 W.        | 119   | 35. 52 N.     | 35. 46 N.    | 17. 36 W. | Funchal, S. 7. 44 W. distant 190 miles.   |
| Thursday,  | May 3    |                                                                                                   | S. 35. 30 E.    | 135   | 34. 1 N.      | 33. 56 N.    | 16. 1 W.  | Funchal, S. 34. 15 W. distant 94 miles.   |
| Friday,    | May 4    | Came to an anchor in Funchal Road, where we lay till May the 27th, and then failed for Teneriffe. |                 |       |               |              |           |                                           |
| Tuesday,   | May 27   |                                                                                                   | S. 1° 30' E.    | 100   | 30. 31 N.     | 30. 31 N.    | 16. 22 W. | Salvages, S. 37. 52 E. distant 39 miles.  |
| Wednesday, | May 28   |                                                                                                   | S. 14° E.       | 107   | 28. 47 N.     | 28. 48 N.    | 15. 35 W. | Teneriffe, S. 47. 23 W. distant 30 miles. |
| Thursday,  | May 29   |                                                                                                   | S. 25 E.        | 20    | 28. 30 N.     |              | 15. 43 W. | Teneriffe, S. 84. 26 W. distant 31 miles. |
| Friday,    | May 30   |                                                                                                   | S. 84 W.        | 33    | 28. 27 N.     |              | 16. 20 W. | Anchored in Santa Cruz Road.              |

*The Method of finding the LATITUDE at SEA, by taking two Altitudes, either in the Forenoon or Afternoon, having the intermediate Time measured by a common Watch, with Ease and Accuracy, independent of the Sun's Meridian Altitude.*

### GENERAL RULES.

1st. **T**O the secant of the latitude by account, add the secant of the sun's declination, (rejecting their indexes) and call that sum the logarithm ratio. \*

2d. From the natural sine of the greatest altitude, subtract the natural sine of the least altitude, and find the logarithm of their difference, and write it under the logarithm ratio.

3d. Subtract the hours and minutes when the altitudes were taken from each other, and half the difference call half-elapsed time.

4th. With half the elapsed time enter the tables, and from the column of half-elapsed time take out the logarithm answering thereto, and set it down under the logarithm ratio.

5th. Add these three logarithms together, and with their sum enter the tables in the column of middle time, where, having found the logarithm nearest thereto, take out the time corresponding to it, and put it down under half the elapsed time.

6th. Subtract the less from the greater, and the difference will be the time from noon, when the greatest altitude was taken.

7th. With this time enter the tables, and from the column of rising, take out the logarithm corresponding to it; from this logarithm subtract the logarithm ratio, the remainder will be the logarithm of a natural number, which, being found in the common table of logarithms, and added to the natural sine of the greatest altitude, will give the natural sine of the sun's meridian altitude.

Having the meridian altitude of the sun at noon, the latitude is found by the usual method.

N. B. If the latitude, found by the above process, should differ widely from the latitude by account, it will be proper to repeat the operation; using the latitude last found instead of the latitude by account, till the result gives a latitude nearly agreeing with the latitude used in the computation.

\* The arithmetical comp. of the co-sine of any angle is equal to the logarithmic secant of that angle, omitting the first figure in the index; thus the secant of  $46^{\circ} 50'$  is 10.16487, and omitting the first figure 1, leaves 0.16487, the secant less radius, or the arithmet. comp. of co-sine  $46^{\circ} 50'$ .

E X A M -

## EXAMPLE I.

Being at sea in latitude  $46^{\circ} 50'$  north by account, when the sun's declination was  $11^{\circ} 17' N.$  at 10 H. 2 M. in the forenoon, the sun's altitude was  $46^{\circ} 55'$ , and at 11 H. 27 M. in the forenoon, the second altitude was  $54^{\circ} 9'$ . Required the true latitude, and true time of the day when the greatest altitude was taken?

Times.

H. M. s. Lat.  $46^{\circ} 50'$ . Secant ——— 0.16487

11 27 0

10 2 0 Dec. 11 17 Seceant ——— 0.00848

Ela. T. 1 25 0

Added gives the log. ratio 0.17335

$\frac{1}{2}$  El. T. 0 42 30

The sun's gr. alt. at 11 H. 27 M. is  $54^{\circ} 9'$  Its nat. sine 81055

The sun's least alt. at 10 H. 2 M. is  $46^{\circ} 55'$  Its nat. sine 73036

The remainder of diff. of nat. fines 8019

Log. ratio ——— 0.17335

The common log of the diff. N. E. 8019 3.90412

In the tables in col.  $\frac{1}{2}$  ela. time for 42 M. 30 S. is 0.73429

Their sum of the log. in middle time ——— 4.81176

H. M. s.

The H. M. &c. for which by the new tables is 1 15 30

Subtract half elapsed time ——— 42 30

The diff. is the true space of time the sun had to rise to the meridian when the greatest altitude was taken } 0 33 00

H. M.

Time per watch 11 27

Sub. from 12 0

0 33 Finding they agree, the watch is right.

Enter the tables with 33 M. under col. of rising, and } you will find the log. ——— 3.01488

From which subtract the log. ratio ——— 0.17335

To the natural number of which is 694 ——— 2.84153

To the natural sine of the greatest alt. ——— 81055

Add the natural number of the above log. ——— 694

The sum is the natural sine of the sun's meridian altitude,  $54^{\circ} 50'$  } 81749

The natural sines are found in table XVII.

The half-elapsed time, &c. in table XVI.

D d

The



90° 0'

54 50

The sun's zen. dist. 35 10  
 The sun's declination 11 17

By observing the sun's merid. alt.  
 the same day, the lat. was found  
 to be 46° 28' N.

Lat. — 46 27

## EXAMPLE II.

Being at sea in lat. 47° 19' N. by account, when the sun's declination was 12° 16' N. at 10 H. 24 M. A. M. per watch, the sun's alt. was 49° 9', at 1 H. 14 M. P. M. his alt. was 51° 59'. Required the latitude?

| H.                   | M. | S. |                  |                                         |                   |          |         |
|----------------------|----|----|------------------|-----------------------------------------|-------------------|----------|---------|
| 12                   | 0  | 0  |                  |                                         |                   |          |         |
| 10                   | 24 | 0  |                  |                                         |                   |          |         |
|                      |    |    | Alt.             | Nat. S. Lat.                            | 47° 19'           | 0.16880  |         |
| 1                    | 36 | 0  | 49° 9'           | 75642                                   | Sun's decl. 12 16 | 0.01003  |         |
| 1                    | 14 | 0  | 51 59            | 78783                                   |                   |          |         |
|                      |    |    |                  |                                         | Log. ratio        | 17883    |         |
| Ela. T.              | 2  | 50 | 0                | Diff. N. S.                             | 3141              | Its log. | 3.49707 |
| ½ El. T.             | 1  | 25 | 0                | Its log. in col. of half elaps. time is |                   |          | 0.44077 |
| Sub.                 | 0  | 15 | 0                | Col. of mid. time corresponding to      |                   |          | 4.11667 |
| Tr. Tt.              | 1  | 10 | 0                | Its log. in col. of rising is           |                   |          | 3.66542 |
| T. p. W.             | 1  | 14 | 0                | Log. ratio sub.                         |                   |          | 0.17883 |
| Wat. fast            | 0  | 4  | 0                | 3066 the nat. num. of this log.         |                   |          | 3.48659 |
| N. S. Sun's gr. alt. |    |    |                  | 78783                                   | 90 00             |          |         |
| N. S. S. mer. alt.   |    |    |                  | 81849                                   | = 54 56           |          |         |
|                      |    |    | Sun's zen. dist. |                                         | 35 4              |          |         |
|                      |    |    | Sun's decl.      | —                                       | 12 16 North.      |          |         |
|                      |    |    | Lat. in          |                                         | 47 20 North.      |          |         |

Here the latitude found by computation may be relied on, as it differs but one mile from that used in the operation.

## EXAMPLE III.

Being at sea in lat. 50° 40' North per account, when the sun's declination was 20° 0' south, at 10 H. 17 M. A. M. per watch, the sun's alt. was found 17° 13', at 11 H. 17 M. A. M. per watch, it was found 19° 41'. Required the latitude?

Times.

|                      |                          |                                                |                        |           |
|----------------------|--------------------------|------------------------------------------------|------------------------|-----------|
| Times.               | Alt.                     | Nat. S.                                        | Lat. $50^{\circ} 40'$  | $0,19803$ |
| H. M. S.             |                          |                                                | Decl. $20^{\circ} 00'$ | $0,02701$ |
| 10 17 0              | $17^{\circ} 13' = 29599$ |                                                |                        |           |
| 11 17 0              | $19^{\circ} 41' = 33682$ |                                                | Log ratio              | $0,22504$ |
| Ela. T.              | 1 0 0                    | Diff. N. S. 4083                               | Its com. log.          | $3,61098$ |
| $\frac{1}{2}$ El. T. | 0 30 0                   | Its log. from col. half-elap. time is          |                        | $0,88430$ |
|                      | 1 1 0                    | In col. of mid. time corresponding to          |                        | $4,72032$ |
| Tr. time             | 0 31 0                   | From noon, its log. from col. of rif.          |                        | $2,96067$ |
| T. p. W.             | 0 43 0                   | Log. ratio sub.                                |                        | $0,22504$ |
| W. flow              | 0 12 0                   | 544 N. num. of                                 |                        | $2,73563$ |
|                      | $90^{\circ} 0'$          | 33682 N. S. greatest alt.                      |                        |           |
|                      | 20 1                     | 34226 N. S. of sun's mer. alt. $20^{\circ} 1'$ |                        |           |
| Zen. dist.           | 69 59                    |                                                |                        |           |
| Decl.                | 20 0 S.                  |                                                |                        |           |

Lat.  $49^{\circ} 59' N.$

But as this latitude differs 41 miles from that by account, it will be proper to repeat the operation, using the lat. last found instead of the lat. by account.

|                            |          |                               |                  |           |
|----------------------------|----------|-------------------------------|------------------|-----------|
| $\frac{1}{2}$ Elapsed time | H. M. S. | Lat,                          | $49^{\circ} 59'$ | $0,19178$ |
|                            | 0 30 0   | Decl.                         | $20^{\circ} 0'$  | $0,02701$ |
|                            | 1 0 0    |                               |                  |           |
|                            |          | Log. ratio                    |                  | $0,21879$ |
| True time                  | 0 30 0   |                               |                  | $3,61098$ |
| Time per watch             | 0 43 0   |                               |                  | $0,88430$ |
| Watch flow                 | 0 13 0   | H. M.                         |                  |           |
|                            |          | In col. mid. T. 1 0           |                  | $4,71407$ |
| True time                  | 0 30 0   | Its log. in col. of rising is |                  | $2,93223$ |
|                            |          | Log. ratio                    |                  | $0,21879$ |
|                            |          | 517 Nat. num. of              |                  | $2,71344$ |
|                            |          | 33682 Nat. S. gr. alt.        |                  |           |
| Nat. S. sun's mer. alt.    |          | $34199 = 20^{\circ} 0'$       |                  |           |

Zen. dist.  $70^{\circ} 0'$   
Decl.  $20^{\circ} 0' S.$

The lat.  $50^{\circ} 0'$  north.

D d 2

The

The latitude last found, differing only one mile from that used in the Operation, may be depended on as the true latitude, Hence it is plain, that the operation is repeated with very little additional trouble, but few alterations being necessary.

## EXAMPLE IV.

Being at sea in the latitude of  $60^{\circ} 0'$  north by account, when the sun was on the equator, and consequently had no declination, at 1 H. 0 M. P. M. per watch, his altitude was  $28^{\circ} 53'$ , and at 3 H. 0 M. P. M. per watch, it was  $20^{\circ} 42'$ . Required the true latitude?

| Times.                     |    |    | Alt.                                         | N. S.      | Lat. $60^{\circ} 0' = 0,30103$ |
|----------------------------|----|----|----------------------------------------------|------------|--------------------------------|
| H.                         | M. | s. |                                              |            | Dec. $0 0 = 0,00000$           |
| 1                          | 0  | 0  | 28                                           | 53 = 48303 |                                |
| 3                          | 0  | 0  | 20                                           | 42 = 35347 | Log. ratio 0,30103             |
| Elap. T. 2 0 0             |    |    | 12956                                        |            | Its log. 4,11247               |
| $\frac{1}{2}$ El. T. 1 0 0 |    |    | Its log. in col. of $\frac{1}{2}$ Elap. time |            | 0,58700                        |
| 2 0 0                      |    |    | Its log. in col. of mid. time                |            | 5,00050                        |
| T. fr. N. 1 0 0            |    |    | Its log. from col. of rising                 |            | 3,53243                        |
| D. per W. 1 0 0            |    |    | Log. ratio                                   |            | 0,30103                        |
|                            |    |    | 1704 N. num.                                 |            | 3,23140                        |
|                            |    |    | 48303                                        |            |                                |
|                            |    |    | 90 01                                        |            |                                |
| Nat. S. Sun's mer. alt.    |    |    | 50007 = $30^{\circ} 0'$ Sun's meridian alt.  |            |                                |
|                            |    |    | .60 0 Latitude                               |            |                                |

The latitude by computation, coming the same with the latitude by account, shews that the latitude by account was right. From the foregoing examples it is plain, that the operation is the same, whether the sun hath north or south declination. And it will be the same whether the ship is in a north or south latitude. It is also clear, that when the sun has no declination, the secant, rejecting the index of the latitude is the log. ratio.

## EXAMPLE V.

Wanting to go through the N. Channel among the Maldives, and by account being in latitude  $7^{\circ} 40' N$ . the declination being then  $22^{\circ} 47' N$ . at 7 H. 25 M. 40. S. A. M. the true altitude of the sun's centre was  $22^{\circ} 30'$ , and at 10 H. 31 M. 48 S. A. M. it was found  $63^{\circ} 40'$ . Required the ship's true latitude?

Times



|                      |                |                                                 |                                            |                             |                |
|----------------------|----------------|-------------------------------------------------|--------------------------------------------|-----------------------------|----------------|
|                      | H. M. s.       | Alt.                                            | Nat. S.                                    | Lat. by ac. $7^{\circ} 40'$ | 0,00390        |
| Times                | 10 31 48       | $63^{\circ} 40'$                                | 89623                                      | Declin. 22 47               | 0,03528        |
|                      | <u>7 25 40</u> | 22 30                                           | <u>38268</u>                               |                             |                |
|                      |                |                                                 |                                            | Log. ratio                  | 0,03918        |
| Elap. T.             | 3 6 8          |                                                 | 51355                                      | Its log.                    | 4,71058        |
| $\frac{1}{2}$ El. T. | 1 33 04        | Its log. in col. of $\frac{1}{2}$ elap. time is |                                            |                             | 0,40368        |
|                      | <u>3 1 30</u>  |                                                 |                                            | H. M. s.                    |                |
|                      |                |                                                 |                                            | 3 1 30                      | <u>5,15344</u> |
| True T.              | 1 28 26        | Its log. in col. of rising is                   |                                            |                             | 3,86709        |
| T. p. W.             | <u>1 28 12</u> |                                                 |                                            | Log. ratio                  | 0,03918        |
| W. flow              | 0 0 14         | 6728                                            | Nat. num.                                  |                             | 3,82791        |
|                      | 90 00          | 89623                                           | N. S. gr. alt.                             |                             |                |
| Mer. alt.            | <u>74 29</u>   |                                                 |                                            |                             |                |
|                      |                | 96351                                           | N. S. Sun's mer. alt. = $74^{\circ} 29'$ . |                             |                |
| Zen. dist.           | 15 31          |                                                 |                                            |                             |                |
| Decl.                | <u>22 47</u>   |                                                 |                                            |                             |                |
| Lat. in              | 7 16 north.    |                                                 |                                            |                             |                |

N. B. As the tables are only calculated to 30 seconds, the log. for any intermediate seconds is found by taking the difference between the log. next greater and next less, and saying, as 30 seconds is to that difference, so is the given seconds to the difference of the logarithms; or, if it be any even part, take such a part of the difference, and apply it to the next less logarithm; but in these operations a few seconds are not regarded.

## SECOND OPERATION.

|                     |                            |                      |                     |
|---------------------|----------------------------|----------------------|---------------------|
|                     | Lat.                       | $7^{\circ} 16'$      | 0,00350             |
|                     | Dec.                       | 22 47                | 0,03528             |
|                     | Log. ratio                 |                      | 0,03878             |
| H. M. s.            |                            |                      | 4,71058             |
| 3 1 30              |                            |                      | 0,40368             |
|                     | H. M. s.                   |                      |                     |
| 1 33 0              | 3 1 30                     |                      | 5,15304             |
| True time           | 1 28 30                    |                      | 3,86709             |
| N. S. gr. alt.      | 89623                      | Log. ratio           | 0,03878             |
|                     | 6735 N. num.               | Log.                 | 3,82831             |
| N. S. Sun's m. alt. | 96358 = $74^{\circ} 29'$ . | Hence the lat. in is | $7^{\circ} 16' N$ . |

The latitude last found, agreeing with that used in the operation, it may be taken as the true latitude ; and the operation is repeated with

with very little additional trouble, few alterations being necessary. Hence it is plain, that if you are mistaken in the latitude by account, yet by repeating the work two or three times, making use of the latitude last found in the next operation, it will at last discover itself to be true, by being equal to the last supposition, which evidently shews the excellency of these tables.

In the former examples we have considered both altitudes taken at the same place or station; but as that is seldom the case at sea, the necessary correction for any alteration of station may be readily made as follows:

Suppose the first altitude in the forenoon at  
The second altitude in the afternoon at 2 H. 43 M.  
Difference of longitude made is 30 Miles W. equal to

H. M.  
10 26  
14 43  
0 2

14 41  
10 26

Subtracted is the elapsed time

4 15

If a ship has been sailing to the eastward, the above two minutes must be added; but unless the difference of longitude be considerable, it is not worth notice, as it will make a very inconsiderable error in the latitude.

Again, if the ship sails or makes towards that point of the compass which the sun bears upon, she must raise the sun's altitude as many minutes as the miles she has run towards it; therefore the miles run towards the sun must be added to the first altitude; but if sailing from the sun, the same must be subtracted; if they are but few, they are not worth minding; and then the seaman may make a very good estimation by looking at the log-board only, who, by that, will be able to ascertain the distance sailed to, or from the sun, between the observations, which will be of sufficient exactness in the practice of navigation; and if the ship makes an angle with the sun's bearing, it may be readily found by the table of difference of latitude and departure, and then either add or subtract, according as the case requires; as may be seen in the following examples, which are inserted for the benefit of those who require a greater degree of accuracy.

#### EXAMPLE VI.

Suppose a ship from the Bay of Biscay, bound to the English Channel, in a brisk gale running N. by E.  $\frac{1}{4}$  E. per compass, at the rate of 9 knots per hour, at 10 H. 0 M. A. M. per watch; observed the sun's altitude  $13^{\circ} 18'$  bearing South  $\frac{1}{4}$  E. by compass, and at 1 H. 40 M. P. M. per watch, the sun's altitude again was found  $14^{\circ} 15'$ , the latitude by account being  $49^{\circ} 17' N.$  and the sun's declination  $23^{\circ} 82' S.$  Required the true latitude?

The

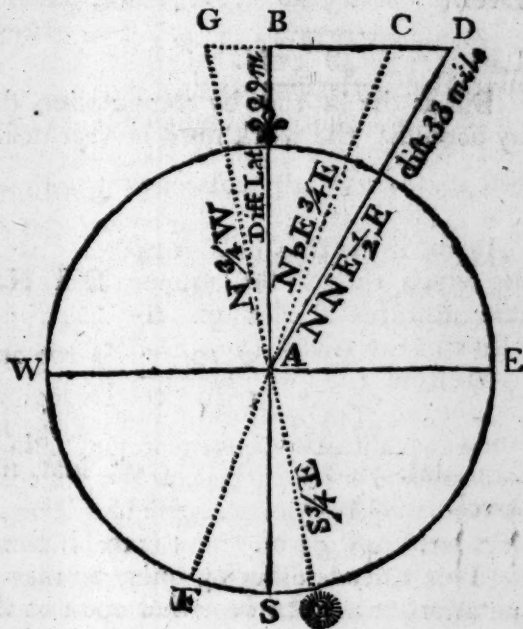
*The Correction to the First Altitude.*

The time of the first observation is 10 H. 0 M. A. M. and of the second 1 H. 40 M. P. M. the elapsed time is 3 hours 40 M. and the rate of sailing is 9 miles per hour; then say, by the Rule of Three, as 1 H. is to 9 miles, so is 3 H. 40 M. to 33 miles, the distance run in the elapsed time.

Again, the sun's bearing at the first observation is south  $\frac{3}{4}$  E. the opposite point to which is N.  $\frac{3}{4}$  W. or  $\frac{3}{4}$  point, and the ship's course during the elap. time is N. by E.  $\frac{3}{4}$  E. 1  $\frac{3}{4}$  points, so the angle of ship's course with the sun's bearing is 2  $\frac{1}{2}$  points.

Now in the table of difference of latitude and departure, to the course 2  $\frac{1}{2}$  points, and distance 33, the difference of latitude is 29, and the ship is sail from the sun: therefore from the first observed altitude  $13^{\circ} 18'$  take 29', the remainder  $12^{\circ} 49'$ , the first altitude corrected, which is to be used in the operation, as follows.

Let the circle represent the compass N, S, E, W, and A the ship's place. Take the ship's course N. by E.  $\frac{3}{4}$  E. or 1  $\frac{3}{4}$  point, and set it off from the north towards the east; take the sun's bearing S.  $\frac{3}{4}$  E. or  $\frac{3}{4}$  of a point, and set it off from the south towards the east; the opposite point is A G, N.  $\frac{3}{4}$  W. then will G A C be the angle the ship has made during the elapsed time, which angle being set off from the north, (or meridian) to the east, will be the true course the ship has made from the sun, as the angle B A D.



From A to D set off 33 miles, the distance sailed in the elapsed time, from D draw a line parallel to the E. and W. to cut the north, or meridian line at B, then A B will be the difference of latitude 29 miles, that the ship has sailed from the sun during elapsed time; which being subtracted from the first altitude leaves the first altitude  $12^{\circ} 49'$  which is to be used in the operation. Had the ship sailed towards the sun, the above 29 miles must have been added to the first altitude.

Alt.



|                      |          |                               |         |            |         |         |
|----------------------|----------|-------------------------------|---------|------------|---------|---------|
|                      | H. M. s. | Alt.                          | Nat. S. | Lat.       | 49° 17' | 0,18554 |
| Times                | 10 0 0   | 14° 15' = 24615               |         | Decl.      | 23 28   | 0,03749 |
|                      | 1 40 0   | 12 49 = 22185                 |         |            |         |         |
| Ela. T.              | 3 40 0   | Diff. N. S. 2430              |         | Log. ratio |         | 0,22303 |
|                      |          |                               |         | Its log.   |         | 3,38561 |
|                      |          |                               |         | Its log.   |         | 0,33559 |
| $\frac{1}{2}$ El. T. | 1 50 0   |                               |         |            |         |         |
|                      | 0 10 0   | Time corresponding to         |         |            |         | 3,94423 |
|                      | 1 40 0   | Its log. in col. of rising is |         |            |         | 3,97170 |
|                      |          |                               |         | Log. ratio |         | 0,22303 |
|                      | 90 0     | 5606 Nat. num. of             |         |            |         | 3,74867 |
|                      | 17 35    | 24615                         |         |            |         |         |
| Zen. dist.           | 72 25    | N. S. M. Alt. 30221 = 17 35   |         |            |         |         |
| Decl.                | 23 28    |                               |         |            |         |         |
| Lat.                 | 48 57 N. |                               |         |            |         |         |

But as the latitude by computation differs considerably from that by account, the work must be repeated.

|            |          |                                |                                    |
|------------|----------|--------------------------------|------------------------------------|
|            |          | Lat.                           | 48° 57' = 0,18262                  |
|            |          | Decl.                          | 23 28 = 0,03749                    |
|            |          | Log. ratio                     | 0,22011                            |
|            | H. M. s. | Diff. N. S. 2430               | Its log. 3,38561                   |
|            | 1 50 0   |                                | Its log. 0,33559                   |
|            | 0 10 0   | Time answering to              | 3,94131                            |
|            | 90 0     | 1 40 0                         | Its log. in col. of rising 3,97170 |
|            | 17 37    |                                | Log. ratio 0,22011                 |
| Zen. dist. | 72 23    | 5644 Nat. num. of              | 3,75159                            |
| Decl.      | 23 28    | 24615                          |                                    |
| Tr. lat.   | 48 55 N. | 30259 N. S. mer. alt. 17° 37'. |                                    |

This latitude differing only 2 miles from that used in the computation, it may be depended upon as the true latitude.

#### EXAMPLE VII.

A ship sailing N. E. half E. by compass, at the rate of 9 knots an hour, at 0 H. 31 M. 40 S. P. M. per watch I found the altitude of the sun's lower limb 28° 20' above the horizon of the sea, the eye being elevated 20 feet above the surface of the water, and the sun's bearing by compass being at the same time S. by W. and at 2 H. 58 M. 20 S. P. M. by watch, the altitude of the sun's lower limb was 16° 41' above the horizon, the eye being elevated as before, and the latitude by account, at the time of the last observation, was 48° 0' north, and the declination 13° 17' south. Required the true latitude at taking the last observation?

First

|                                      |             |              |             |
|--------------------------------------|-------------|--------------|-------------|
| First observed alt. sun's lower limb | 28° 20'     | Second ditto | 16° 41'     |
| Refraction to be subtracted          | <u>2</u>    |              | <u>3</u>    |
| Correction for refraction            | 28 18       |              | 16 38       |
| Dip. of the horizon subtracted       | <u>4</u>    |              | <u>4</u>    |
| App. alt.                            | 28 14       |              | 16 34       |
| Sun's semi-diameter added            | <u>0 16</u> |              | <u>0 16</u> |
| Correct altitude of sun's centre     | 28 30       |              | 16 50       |

*Correction for the First Altitude.*

The time of the first observation 0 H. 31 M. 40 S. P. M. of the second 2 H. 58 M. 20 S. P. M. so the elapsed time is 2 H 26 M. 40 S.: the rate of sailing is 9 miles per hour. Then as 1 H.: 9 miles :: 2 H. 26 M. 40 S.: 22 miles, the distance run in the elapsed time.

Again, the sun's bearing at the first observation is S. by W. the opposite point to which is N. by E. or 1 point.

The ship's course during the ela. time is N. E.  $\frac{1}{2}$  E. or 4  $\frac{1}{2}$  pts.

So the angle of the ship's course with the sun's bearing is } N. E. by N.  $\frac{1}{2}$  E. 3  $\frac{1}{2}$  pts.

In the table of difference of latitude and departure, to the course 3  $\frac{1}{2}$  points, and distance 22 miles, the difference of latitude is 17 miles, while the ship sails from the sun.

Wherefore, first observed altitude 28° 30' - 17' = 28° 13' the first correct altitude to be used in the operation.

| H. M. s.                     | Alt.                                            | N. S. | Lat. by ac. | 48° 0' | 0,17449 |
|------------------------------|-------------------------------------------------|-------|-------------|--------|---------|
| Times 0 31 40                | 28° 13'                                         | 47281 | Declin.     | 13 17  | 0,01178 |
| 2 58 20                      | 16 50                                           | 28959 |             |        |         |
|                              |                                                 |       | Log. ratio  |        | 0,18627 |
| Ela. T. 2 26 40              | Diff. N. S.                                     | 18322 | Its log.    |        | 4,26297 |
| $\frac{1}{2}$ El. T. 1 13 20 | Its log. from col. of $\frac{1}{2}$ elapf. time |       |             |        | 0,50232 |
| 1 46 30                      | In col. of mid. time corresponding to           |       |             |        | 4,95156 |
| 0 33 10                      | Its log. from col. of rising                    |       |             |        | 3,01923 |
|                              | Log. ratio                                      |       |             |        | 0,18627 |
|                              | N. S. gr. alt. 47281                            |       |             |        |         |
| Mer. alt. 90 0               | 681 N. num. of                                  |       |             |        | 2,83296 |
| 28 40                        |                                                 |       |             |        |         |
|                              | N. S. mer. alt. 47962 = 28° 40'.                |       |             |        |         |
| Zen. dist. 61 20 S.          |                                                 |       |             |        |         |
| Decl. 13 17 S.               |                                                 |       |             |        |         |
| Lat. 48 3 N.                 |                                                 |       |             |        |         |

And as it differs but three miles from the latitude by account, it may be taken as the true latitude.

E c

*Questions*

*Questions for Exercise.*

1st. Being at sea in latitude by account  $39^{\circ}28'N$ . when the sun's declin. was  $20^{\circ}41'N$ . at 11 H. 30 M. 15 S. A. M. per watch, the altitude of the sun's lower limb was observed to be  $68^{\circ}18'45''$  and at 12 H. 26 M. 28 S. P. M. it was  $70^{\circ}58'$ , the height of the eye being 21 feet above the surface of the sea. Required the true lat. of the ship? Answer,  $39^{\circ}28'N$ .

2d. Being at sea in lat.  $50^{\circ}40'N$ . by account, at 10 H. 17 M. 30 S. A. M. per watch, the altitude of the sun's lower limb was observed to be  $17^{\circ}4'\frac{1}{4}$ , and at 11 H. 17 M. 30 S. it was  $19^{\circ}31'\frac{1}{2}$ , the declination being then  $20^{\circ}N$ . and height of the eye 21 feet above the sea. Required the latitude in? Answer,  $50^{\circ}0'N$ .

3d. Suppose a ship at sea in lat.  $47^{\circ}34'N$ . by account, at 9 H. 55 M. 30 S. by watch, the altitude of the sun's lower limb was  $17^{\circ}24'$ , bearing by compass S. by E.  $\frac{1}{4}$  E. and at 12 H. 54 M. 10 S. his altitude was  $21^{\circ}45'\frac{1}{2}$ , the declin. being then  $19^{\circ}30'S$ . the height of the eye 20 feet above the sea, and the ship's course by compass was E.  $\frac{1}{2}$  S. at the rate of 7 knots per hour. What was the true latitude? Answer,  $27^{\circ}24'N$ .

4th. At 11 H. 28 M. 20 S. A. M. per watch, the altitude of the sun's lower limb was  $28^{\circ}18'$ , the sun bearing then S. by W. by compass. At 2 H. 58 M. 20 S. P. M. his altitude was  $16^{\circ}40'$ , the height of the eye 20 feet, his declination being then  $13^{\circ}17'N$ . and the latitude then by account  $47^{\circ}50'N$ . the ship's course during the elapsed time was N. E. with her larboard tacks on board, sailing at the rate of six knots, and made half a point leeway. What latitude was she in when the last altitude was taken? Answer,  $48^{\circ}9'N$ .

By the ship's course per compass is to be understood, its course made good, leeway, if any, being first allowed, or the course, by compass, corrected for the leeway only, but not for the variation. Had the variation of the compass been applied, both to the ship's course and the sun's bearing, it would not have made any difference in the operation or result, as the angle formed by them will always be the same, whether they are both estimated by the compass, or when the variation is allowed on both.

This method of finding the latitude is of excellent use, since there are so many circumstances at sea, which deny the opportunity of having the sun's meridian altitude; and as the knowing the true latitude is of the greatest consequence, especially in coming into the English channel, &c. where there are frequent obstructions of clouds, every seaman ought to be ready at determining his latitude, by this method, whenever an opportunity offers, lest he should not see the sun upon the meridian.

NOTE. The nearer to noon the observations are taken, the better; provided the elapsed time be not much less than half the interval of time, when they are both taken on the same side of noon, nor much greater



greater than once and half the greater interval, when taken on different sides of noon.

*To find the LATITUDE by one ALTITUDE of the Sun, when the Time is not more distant than one Hour from Noon.*

## R U L E.

*To find the true Time.*

**W**HEN the sun's declination, and complement of the latitude are both north or both south their sum, but if one be north and the other south, their difference is the meridian altitude.

From the natural sine of the sun's meridian altitude, subtract the natural sine of the true altitude.

Then add together,

The log. co. secant of the comp. of the lat. }

The log. secant of the sun's declination }

reject. their indexes

and the common logarithm of the difference of natural sines into one sum. The sum of these three logarithms, being found in the column rising, the hours, minutes, and seconds corresponding to it, will be the true time from noon when the altitude was taken.

## E X A M P L E.

Being at sea in lat.  $50^{\circ} 40' N.$  by account when the sun's declination was  $20^{\circ}$  south, at 11 H. 17 M. A. M. per watch, sun's alt. was  $19^{\circ} 41'$ . Required the true time?

Comp. lat.  $39. 20 N.$

Co. sec. 0. 19803

Declination  $20. 00 S.$

Sec. 0. 02701

Sup. m. alt.  $19. 20$  Nat. sine 33106

L. ra. 0. 22504

Obser. alt.  $19. 41$  Nat. sine 33682

576 Co. l. 2. 76042

H. M. S.

12. 00. 00

Log. in col. of rising 2. 98546 is = 00. 32. 00

True time at sea 11. 28

Having the true time previous to the observation to find the change of altitude

Add together the logarithm found in the col. of rising answering to the minutes and seconds the sun had to rise when the altitude was taken, and the secant of the supposed meridian altitude from this sum, (the index being increased by 5 \*,) subtract the log. ratio the remainder is the log. sine of the change of altitude from the time of observation to noon; which being added to the observed altitude gives the sun's meridian altitude.

\* The 5 is the index of six hours in the column of rising.

|                                 |                |              |       |
|---------------------------------|----------------|--------------|-------|
| Log. in col. of rising of 32 M. | 2.98820        | Obser. alt.  | 19.41 |
| Log. sec. m. alt. 19° 20'       | 0.02521        | Cha. of alt. | + 21  |
| Increase index                  | 5.             | Tr. m. alt.  | 20.02 |
|                                 | <u>8.01341</u> |              |       |
| Subtract log. ratio             | 0.22504        |              |       |
| Log. fine chan. of alt. 21 min. | 7.78837        |              |       |

## EXAMPLE II.

Being at sea in lat. 60 north by account, when the sun was on the equator at 1 H. 0 M. P. M. per watch, the sun's alt. was 28° 53' Required the true time and latitude in?

|                           |                                |                  |               |
|---------------------------|--------------------------------|------------------|---------------|
| Com. Lat. 30.00 N.        | Nat. fine 50000                | Co. sec. 0.30103 | L. ratio      |
| Ob. alt. 28.53            | Nat. fine 48303                |                  |               |
| Ch. of lat. 1.08          | 1697                           | Com. lo. 3.22968 | H. M.         |
| T. m. alt. 30.01          | Log. in col. of rising is =    | 3.53071          | = 1.00 Tr. T. |
| Zen. dist. 59.59 N. la.   | Log. sec. mer. alt.            | 0.06247          |               |
| The S. being on the equa. | Increase index                 | 5.               |               |
|                           |                                | <u>8.59318</u>   |               |
|                           | Subtract log. ratio            | 0.30103          |               |
|                           | Log. fine chan. of alt. 1° 08' | 8.29215          |               |

## EXAMPLE III.

Being at sea in lat. 39 28 north by account, sun's declination 20° 41' north at 26 M. 28 S. P. M. sun's alt. was 71° 10'. Required the true time and latitude at the ship?

|              |                                     |                            |                      |
|--------------|-------------------------------------|----------------------------|----------------------|
| Comp. lat.   | 50.32 N.                            | Co. sec.                   | 0.11239              |
| Declina.     | 20.41 N. Nat. fine 94674            | Secant                     | 0.02893              |
| Sup. m. alt. | 71.13                               | Nat. fine 94646            | 0.14132              |
|              |                                     | 28                         | Com. log. 1.44716    |
|              |                                     |                            | M. S.                |
| Obfer. alt.  | 71.10                               | Lo. in col. of rifing is = | 1.58848 = 6.30 T. T. |
| Chan. alt.   | 3                                   | Log. sec. sup. mer. alt.   | 0.49216 at th.       |
| T. mer. alt. | 71.13                               | Increase Index             | 5                    |
| Zen. dist.   | 18.47 S.                            |                            | 7.08064              |
| Declin.      | 20.41 N. Subtract log. ratio        |                            | 0.14132              |
| Lat. in      | 39.28 N. L. fine chan. of alt. 3 m. |                            | 6.93932              |

NOTES.

## NOTES.

1st. The altitudes for determining how much the watch differs from apparent time, had better be taken in the morning, or evening, when the sun's altitude does not exceed 18 degrees.

2d. An error in the supposed latitude, can make very small difference in the change of altitude; and the nearer the altitude is taken to noon the better to find the change of altitude.

3d. This method is not to be depended on should the apparent time exceed an hour from noon, and in some instances not then; such as altitudes taken near the equator; or when the meridian altitude exceeds 60 degrees; nor is there much occasion for this method, or that of the double altitudes there, since there is generally a clear horizon, and consequently a meridian altitude easily obtained.

*To find the Latitude by the Meridian Altitude of the Moon.*

**I**N page 6th of the month in the Nautical Almanac, find the time of the moon's passing over the meridian of Greenwich.

Turn the longitude into time, by table XI. and add it to the above time, if it be west, but subtract it, if it be east: the sum or difference, will be nearly the time of her passage over the meridian of the place of observation; which call reduced time.

In page 7th of the month in the Almanac, find the moon's semidiameter and horizontal parallax, at the reduced time.

Take the difference between the moon's semidiameter and dip, and add it to the observed altitude, if the lower limb was observed, but subtract it, if the upper limb was observed: the sum or difference will be the apparent altitude of her centre.

From the proportional logarithm of the moon's horizontal parallax, found in table IX. increasing its index by 10, subtract the log. cosine of the moon's apparent alt. the remainder will be the prop. log. of the moon's parallax in altitude, from which take her refraction, the difference will be a correction, which being added to the apparent altitude, will give the true altitude of her centre: hence the zenith distance, to which apply her declination, and you will have the latitude.

**NOTE.** The moon's declination is set down in page the 6th of the month for every noon and midnight in the Nautical Almanac.

Therefore find the declination for the nearest noon and midnight both before and after the reduced time, and take the difference.

Then as 12 hours: is to the difference in 12 hours:: so is the reduced time: to a proportional part; which being added to, or subtracted from the declination the noon or midnight before the reduced time, according as it is increasing or decreasing, will give the declination at the time and place of observation.

## EXAMPLE I.

Suppose on Sept. 21, 1796, in long.  $45^{\circ}$  west, the altitude of the moon's lower limb, when on the meridian south of the observer, should



should be  $67^{\circ} 43' \frac{1}{2}$ , the eye being 23 feet above the sea. Required the latitude?

By the Almanac, the moon passes over the meridian of Greenwich that day at 16 H. 10 M. afternoon, and the  $45^{\circ}$  west turned into time, and added to it, gives 19 H. 10 M. that is 7 H. 10 M. past midnight, the time she passes the meridian of the place of observation.

Hor. par.  $59' 15''$  Prop. log. 10,4826 Moon's obs. Alt.  $67^{\circ} 43' 30''$   
 App. alt.  $67 55$  Log. cosine 9,5751 Sem. diam.  $16' 8''$  } 11 34  
 Dip 4 34

Prop. L. of M's P. in alt.  $22' 16''$  9075

Moon's refraction

App. alt.

23

67 55 4

21 53

Correct. of moon's alt.

21 53

Sep. 21st,

Moon's decl. at midnight  $17^{\circ} 37'$  17 37 M's tr. alt.  $68 16 57$

Sept. 22d, ditto at noon 19 23 1 3 Moon's decl. 90

1 46

18 40

Zen. dist.

21 43 38

As 12 H. :  $1^{\circ} 46' :: 7$  H. 10 M. :  $1^{\circ} 3'$

Decl.

18 40 0N.

Lat. in

40 23 3N.

NOTE. If the nearest minutes are taken and the seconds rejected, it will be sufficiently exact for the purpose of finding the latitude.

### EXAMPLE II.

Suppose on Dec. 13, 1796, in long.  $30^{\circ}$  east, the alt. of the moon's upper limb should be observed when on the meridian, being then fourth  $56^{\circ} 15'$ , the eye 20 feet above the sea. Required the latitude?

The moon passes over the meridian of Greenwich that day, by the Almanac, at 11 H. 23 M. afternoon. The long. in time 2 H. subtracted from 11 H. 23 M. leaves 9 H. 23 M. for the time she passes the meridian at the place of observation.

At this time the moon's semi-diameter is found to be  $16' 41''$ , and her horizontal parallax  $61' 10''$ .

H. par.  $61' 10''$  P. L. 10,4687 Alt. M's up. L.  $56^{\circ} 15' 0$

Ap. alt.  $55^{\circ} 54'$  Cos. 9,7487 Sem. diam.  $16' 41''$

+ Dip. 4 16

20 57

P. log. of P. in alt.  $34' 18''$  7200

Refraction

38

App. alt.

55 54 3

Cor. of moon's alt.

33 40

33 40

Moon's alt.

56 27 43

Moon's decl. Dec. 13 at noon  $19^{\circ} 18'$

90 0 0

Ditto at midnight

20 59

Zen. dist.

33 32 17

Diff. 1 41

As 12 H. :  $1^{\circ} 41' :: 9$  H. 23 :  $1^{\circ} 19'$  } = Decl.

20 37 0

Decl. at noon 19 18

Lat.

54 9 17N.

70

*To find the Latitude by the Meridian Altitude of a Planet.*

In page 4th of the month in the Nautical Almanac are given the declinations and times of the planets' passage over the meridian of Greenwich every six days.

Reduce the longitude into time, and add it to, or subtract it from the times of their passages over the meridian of Greenwich, according as their longitude is east or west: the sum or difference will be the time they pass the meridian of the place of observation: correct the observed altitude for the dip, and refraction, with this correct altitude and declination find the latitude; as for

## EXAMPLE.

Suppose in long.  $45^{\circ}$  W. on Oct. 1, 1796, the meridian altitude of Jupiter, when south of the observer, should be  $41^{\circ} 30'$ , the eye 22 feet above the sea, and the latitude be required?

By the Almanac, Jupiter passes the meridian of Greenwich that day at 9 H. 53 M. afternoon; and 3 H. the long. in time, added to it gives 53 M. after 12 at night, when he passes over the meridian of the place of observation.

$$\begin{array}{rcl} & \text{Meridian alt.} & 41^{\circ} 30' 0'' \\ \text{Dip. } 4' 28'' + & \text{Refract. } 1' 4'' = & 0 \quad 5 \quad 32 \end{array}$$

$$\begin{array}{rcl} \text{True alt.} & & 41 \quad 24 \quad 28 \\ & & \hline & & 90 \end{array}$$

$$\begin{array}{rcl} \text{Zen. dist.} & & 48 \quad 35 \quad 32 \text{S.} \end{array}$$

$$\begin{array}{rcl} \text{Decl.} & & 11 \quad 12 \quad 0 \text{S.} \end{array}$$

$$\begin{array}{rcl} \text{Lat.} & & 37 \quad 23 \quad 32 \text{N.} \end{array}$$

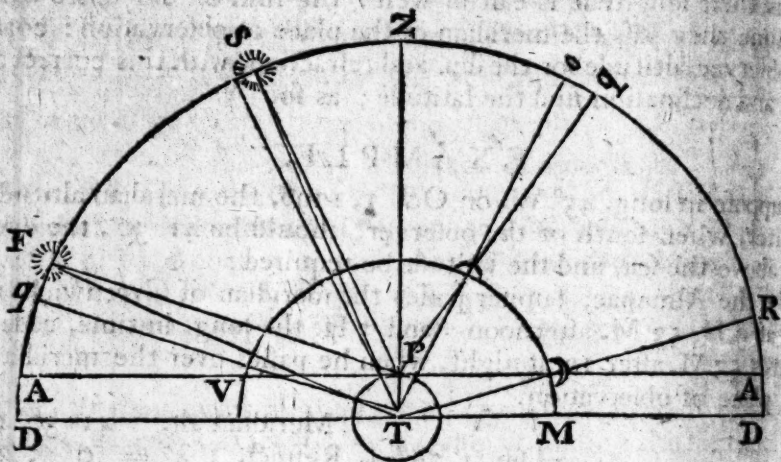
The declination of the planets are set down for every 6 days, but may be found for intermediate days by taking proportional parts.

## OF THE PARALLAX.

**P**ARALLAX is the difference between the altitude of the sun, moon, or star, and the altitude of the same object seen at the same time from the earth's surface; or it is the angle of the earth's semidiameter would appear under by an observer placed at the sun, moon, or star.

The parallax of the heavenly bodies are greatest when in the horizon, hence called the horizontal parallax; that of the moon's is set down in the Nautical Almanacs for every noon and midnight, and lies between  $54'$  and  $62'$ ; the parallax diminishes according to the altitude

altitude of the object until it comes to the zenith, where it is nothing: the difference of the elevation of objects is called the parallax in altitude, and it is easily calculated by saying, as radius is to the horizontal parallax, so is the cosine of the altitude to the parallax in altitude: now, as all objects are depressed by their parallax, so they are elevated above their true altitudes by refraction.



Let P T represent the earth, T the centre, M D V a part of the moon's orbit, DD part of the sun's orbit, and the rational as well as A A is the sensible horizon.

Now, an observer at T will see the moon in the line D R, when another at P at the same time will see her in the line D A in the sensible horizon, and the angle P D T = M T D = A D R is the horizontal parallax set down in the Nautical Almanac for every noon and midnight, and lies between 54' and 62'; this angle diminishes as the object approaches the zenith; for suppose the moon in the line P q the  $\angle q D O = P D T$  is less than the  $\angle A D R = \angle T D P$ , still diminishing until it comes to the zenith Z, where it is nothing. To find the diminution of parallax in altitude, say, as radius : is to the horizontal parallax :: so is the cosine of the apparent altitude : to the parallax in altitude.

The parallax of the moon is greater than any of the rest of the planets, owing to her being nearest the earth, the vast distance of sun and stars rendering their parallax so small, that they are often neglected in nautical calculations; for suppose the sun at F or S, then the  $\angle T F P = q T F$  is the sun's parallax, about  $8\frac{1}{2}$  seconds.

Having the earth's semidiameter and the parallax of any of the planets, their distance may be found, by saying, as the tangent of the parallax : is to the earth's semidiameter in miles :: so is radius : to the distance.

Having the distance, the parallax is found by saying, As the distance



tance : is to radius :: so is the earth's semidiameter : to the tangent of the parallax.

The earth's semidiameter is 1146 nautical leagues, the sun's distance from the earth is 27,809,344, the moon 69,059, Mercury 10,764,563, Venus 20,115,400, Mars 42,372,897, Jupiter 144,635,833, and Saturn 265,283,603 leagues.

*To reduce the Sun's Declination from Noon at Greenwich, to the NOON under any other Meridian. By Table XVIII.*

### RULE.

1st. **W**ITH the longitude in from Greenwich in the top column, expressed both in time and degrees, look for that answering nearest to your longitude in.

2d. Look for the day of the month in the side column, the number of minutes, and seconds where that cuts (in the same column of your longitude in) is either to be added to, or subtracted from the declination that day at Greenwich.

To know whether it is to be added, or subtracted, look at the top and under the column of the day of the month you will see, add in east, or subtract in west, (and *vice versa*) which having done will give the true declination for the noon at the place of observation.

### EXAMPLE.

Required the true declination, October 10, 1796, in longitude 52° E. of Greenwich.

Sun's decl. Oct. 10 at Greenwich 7° 1' 32" per Ephemeris

Varia. of decl. per tables Oct. 9 } 0 3 15 to be sub. in east long.

and long. 52° east gives

True decl. Oct. 10, in long. 52 E. 6 58 17

*To reduce the Sun's Declination from Noon at any Meridian, to any other Time under that Meridian.*

### RULE.

1st. With the time from noon in the top column, look for that answering nearest to this time.

2d. Look for the day of the month in the side column, the number of minutes and seconds, where that cuts (in the same column of the time from noon) is either to be added to, or subtracted from the declination that day at Greenwich, noon.

To know whether it is to be added or subtracted, look at the top and under the column of the day of the month, you will see add afternoon, or subtract before noon, (and *vice versa*) which you hav-

ing done, will give you the true declination for any time differing from noon.

NOTE. In all calculations for determining the longitude, the sun's declination is taken out of the Nautical Almanac, as it is there calculated to the nearest second.

### EXAMPLE I.

Required the sun's true declination October the 10, 1796, at 8 H. 21 M. in the forenoon in longitude  $52^{\circ}$  east of Greenwich?

|                                                                |   |                     |
|----------------------------------------------------------------|---|---------------------|
| Variation of decl. Oct. 10, per table in long. $52^{\circ}$ E. | } | $0^{\circ} 3' 15''$ |
| subtract in east longitude                                     |   |                     |
| Variation of decl. for 3 h. 39 m. from noon Oct. 10,           | } | $0 3 26$            |
| per tables to be subtracted before noon.                       |   |                     |

|                                                      |           |
|------------------------------------------------------|-----------|
| Sum of variations subtract                           | $0 6 41$  |
| Sun's declination per Nat. Al. Oct. 10, at Greenwich | $7 13 28$ |

|                                                                 |              |
|-----------------------------------------------------------------|--------------|
| True decl. Oct. 10, in long. $52^{\circ}$ E. at 8 h. 21 m. A.M. | $6 54 51 S.$ |
|-----------------------------------------------------------------|--------------|

### EXAMPLE II.

Required the sun's true declination May 7, 1796, at 5 h. 30 m. P. M. and in longitude  $35^{\circ} 30'$  west of Greenwich?

|                                                    |   |          |
|----------------------------------------------------|---|----------|
| Varia. of declination May 7, in long. $53 30$ west | } | H. M. S. |
| Add in west longitude.                             |   |          |
| Varia. of declina. for 5 h. 30 m. from noon May 7, | } | $0 1 41$ |
| per tables to be added afternoon.                  |   |          |

|                                                 |           |
|-------------------------------------------------|-----------|
| Sum of varia. Add, or correction of declination | $0 5 33$  |
| Sun's declination May 7, per Ephemeris          | $17 5 24$ |

|                                                     |            |
|-----------------------------------------------------|------------|
| T. decl. May 7, long. $35. 30$ W. at 3h. 30 m. P.M. | $17 10 57$ |
|-----------------------------------------------------|------------|

The above method will give the sun's declination sufficiently correct for all nautical purposes; but those who wish to come to the greatest degree of exactness may use the following method.

Turn the ship's longitude into time by table XI. and add to it, the time per watch, if the longitude be west, but subtract it if the longitude be east, the sum or difference will be the time at Greenwich, which call the reduced time.

Look in the Nautical Almanac for the given day, and in page the 2d. of the month stands the sun's declination.

If the reduced time be in the morning, take the difference of declination between the noon before, and noon after the reduced time.

Then say by the Rule of Three,

As 24 hours : is to the daily difference of declination :: so is the reduced time, to a number of minutes and seconds, which being added to the declination the noon before if it be increasing, or subtracting it if decreasing, the sum or difference will be the declination at the ship.

To

*To find the apparent Time, and thereby regulate the going of the Watch, and First by Equal Altitudes of the Sun.*

**A**T the time when the watch stands in need of being regulated, for the observations intended, let the sun's altitude be taken at any convenient time in the forenoon, 2, 3, 4, or 5 hours distant from the meridian. Set down the altitude with the corresponding time exactly (the index being already set to the morning altitude :) note down the time of the same altitude in the afternoon; half the sum of these two times, is the apparent time shewn by the clock or watch when the sun was upon the meridian of that place. But it must here be observed, that if the change of declination be considerable during the elapsed time, it must be allowed for, by adding the difference to, or subtracting it from, the second altitude, according as it is increasing or decreasing. Lest that an altitude taken in the forenoon cannot by the interposition of clouds, have a corresponding one in the afternoon; it is therefore proper to take several in the forenoon, in order to secure a corresponding one in the afternoon. And, if several equal altitudes can be taken on both sides of the meridian, it will be best to find the noons for each pair, and the means of all the noons thus found for the true one.

When there is reason to believe that the watch gains or loses considerably, other sets of observations may be taken on successive days, whereby the daily variation may be found and allowed for; by which means the artist will have little more to do in finding his longitude by observation, than to reduce the observed distance of the objects to the true distance of their centers; the ship's time being shewn by the watch previously regulated.

**EXAMPLES.**

May 20, 1796, suppose that at 8 h. 40 m. in the forenoon, and 3 h. 16 m. afternoon by watch, the sun had equal altitudes, and the going of the watch be required?

Now add together

| H. | M. |
|----|----|
| 12 | 0  |
| 8  | 40 |
| 3  | 16 |

2) 23 56

$\frac{1}{2}$  gives noon per watch  
True noon

|    |    |
|----|----|
| 11 | 58 |
| 12 | 0  |

Watch slow

2

March 18, 1796, in lat.  $49^{\circ}$  N. suppose at 8 h. 10 m. 58 f. forenoon, and at 3 h. 58' 34" you have equal altitudes of the sun, Required the going of the watch?

The distance of the time from noon when the first was taken is 3 h. 49 m. 2 f. doubled is 7. h. 38 m. 4 f. and the daily decrease of declin. at this time is  $23' 41''$ .

Now as 23 h. :  $24' 41''$  :: 7 h.  $38' 4''$  :  $7\frac{1}{2}$ .

Hence the index of the quadrant must be set  $7\frac{1}{2}$  forward on the arch, to correspond with the morning alt. whence the watch will be found  $4' 46''$  too fast.

F f 2

Here



Here it is supposed that the ship is lying by, or makes no way through the water ; but if she is sailing to or from the sun, proper allowance must be made for her run, during the elapsed time, but the following methods of finding the time will answer every purpose at sea.

*To find the apparent Time by the Sun's Altitude.*

Find the ship's latitude and longitude by account, at the time of observation, by carrying the reckoning forward to that time.

With a quadrant well adjusted, take the altitude of the sun's lower limb.

Take the difference between the semidiameter and dip of the horizon, and add it to the observed altitude, the sum will be the sun's apparent altitude.

Take the difference between the sun's refraction and parallax in altitude, and subtract it from the apparent altitude ; the remainder will be the true altitude of the sun's centre ; hence the true zenith distance.

Turn the ship's longitude into time, and either add to or subtract from the time per watch, according as it is east or west ; the sum, or difference, will be the reduced or supposed time at the place of observation.

Take the sun's declination out of the Nautical Almanac, and proportion it to the reduced time : with the sun's true declination find the polar distance : then,

Add together    The zenith distance  
                          The co-latitude, and  
                          Polar distance into one sum.

From half this sum subtract the zenith distance, noting the half sum and remainder, then add together

|                                                 |                            |
|-------------------------------------------------|----------------------------|
| The log. co-secant of the comp. of the latitude | } rejecting their indexes. |
| The log. co-secant of the polar distance,       |                            |
| The log. sine of the half sum, and              |                            |
| The log. sine of difference into one sum.       |                            |

Take the log. sine of half the sum of the four logarithms which being doubled and brought into time as before, will give the times from the midnight before the altitude was taken.

Half the sum of these four logarithms will give the log. co-sine of half the hour angle ; which being doubled and turned into time, by allowing 15 degrees for every hour, &c. or more briefly by the table, will give the true time, if the altitude was taken in the afternoon ; but if in the forenoon, its complement to 24 hours will be the true time, reckoned from the preceding, or noon before. Or what perhaps will be found more easy to the learner.

NOTE. The refraction is found in table XII. of this book.

The dip of the horizon, table XIII. in ditto.

The

The sun's parallax in alt. table XIV. in ditto.  
 The sun's decl. in page 2d of the month, and  
 The sun's semidiameter in page 3d of the month in the  
 Nautical Almanac.

## EXAMPLE I.

Suppose on the 7th of May, 1796, at 5 h. 30 m. 32 f. P. M. or  
 afternoon per watch, in latitude  $39^{\circ} 54' N.$  and long.  $35^{\circ} 30'$  west  
 of Greenwich by account, the altitude of the sun's lower limb should  
 be found to  $15^{\circ} 45'$  the eye being 18 feet above the surface of the  
 sea, and the true apparent time when the observation was made was  
 required?

|                                                        |                         |                                                  |                      |
|--------------------------------------------------------|-------------------------|--------------------------------------------------|----------------------|
| Obs. alt. S.'s L. L.                                   | $15^{\circ} 45' 00$     | Lat.                                             | $39^{\circ} 54' N.$  |
|                                                        |                         |                                                  | $90$                 |
| Dip. $4' 3''$ semi. 15 53 diff.                        | 11 50                   | Co-lat.                                          | $50^{\circ} 6$       |
| Ap. alt. S.'s L. L.                                    | $15^{\circ} 56' 50$     |                                                  |                      |
| Refra. $3' 17''$ par. 8' diff.                         | 3 9                     | Sun's decl. May 7, per N. A.                     | $17^{\circ} 5' 24''$ |
| Sun's true alt.                                        | $15^{\circ} 53' 41$     | V. dec. p. tab. for lon. $35^{\circ} 30' W.$ add | 1 41                 |
|                                                        | $90$                    | Ditto for 5 h. 30' from noon add                 | 3 52                 |
| Zenith dist.                                           | $74^{\circ} 6' 19$      | True decl. cor. for lon. and time                | $17^{\circ} 10' 57$  |
|                                                        |                         |                                                  | $90$                 |
|                                                        |                         | Polar dist.                                      | $72^{\circ} 49' 3$   |
| Co-lat.                                                | $50^{\circ} 6' 00$      | Co-secant                                        | 0.11511              |
| Polar dist.                                            | $72^{\circ} 49' 03$     | Co-secant                                        | 0.01983              |
| Sum                                                    | 2) 197 01 22            |                                                  |                      |
| $\frac{1}{2}$ Sum                                      | $98^{\circ} 30' 41$     | Log. sine                                        | 9.99518              |
| Zenith dist. sub.                                      | $74^{\circ} 6' 19$      |                                                  |                      |
| Remainder                                              | $24^{\circ} 24' 22$     | Log. sine                                        | 9.61616              |
| Sum of 4 log.                                          |                         |                                                  | 19.74628             |
| $\frac{1}{2}$ Sum log. co-fi. $\frac{1}{2}$ hour angle | $= 41^{\circ} 41' 44''$ |                                                  | 9.87314              |
|                                                        | $2$                     |                                                  |                      |
| Hour angle                                             |                         |                                                  | 5 33 34              |
| Time at ship per watch                                 |                         | 83 23 28 in time =                               | 5 30 32              |
| Watch slow                                             |                         |                                                  | 3.2                  |

NOTE. The co-secant of any angle arch, (rejecting index) is  
 equal to the arithmetical co-sine of that angle.

By turning the longitude west into time, and adding to the time  
 at the ship, gives the reduced time 7 h. 52 m. and the difference of  
 declination between the 7th and 8th of May  $16' 10''$ , then by the  
 Rule of Three, as  $24 : 16' 10'' :: 7 h. 52 m : 5' 17''$  which being  
 added, the declination May 7 =  $17^{\circ} 5' 24''$  gives  $17^{\circ} 10' 41''$  hence  
 the polar distance is  $72^{\circ} 49' 19''$  and working with which will give  
 the true time, 5 h. 33 m. 32".

EXAM-

## EXAMPLE II.

Suppose that in the forenoon or A. M. on the 9th, of Oct. 1796, in latitude  $51^{\circ} 30' N.$  and long.  $52^{\circ} E.$  the altitude of the sun's lower limb should be found as under, the eye being 18 feet above the sea, and true apparent time of the day was required?

| Times.                                                     |                                       | Altitudes.                                                  |                       |
|------------------------------------------------------------|---------------------------------------|-------------------------------------------------------------|-----------------------|
|                                                            |                                       | Lat. $51^{\circ} 30' N.$                                    |                       |
| H. M.                                                      |                                       |                                                             |                       |
| 20 14                                                      | 12 28                                 | Co. lat. $38^{\circ} 30'$                                   |                       |
| 20 19                                                      | 13 20                                 | S.'s decl. Oct. 10, per Naut. Alm. $7^{\circ} 1' 32''$      |                       |
| 20 30                                                      | 14 51                                 | Var. per tab. for lon. $52^{\circ} E.$ sub. $3^{\circ} 15'$ |                       |
| 3) 61 3                                                    | 40 39                                 | Ditto for 3h. 39m. T. from N. sub. $3^{\circ} 26'$          |                       |
| Mea. 20 21                                                 | 13 33                                 |                                                             |                       |
| S. s fem. $16^{\circ} 5''$ diff. $4' 28''$ diff. $11 37''$ |                                       | Decl. at ship                                               | $6^{\circ} 54' 51''$  |
|                                                            |                                       |                                                             | 90                    |
| App. alt.                                                  | 13 44 37                              | Polar distance                                              | $96^{\circ} 54' 51''$ |
| Refr. — $3' 51''$ — par. $9''$ diff.                       | 3 42                                  |                                                             |                       |
| Sun's true alt.                                            | 13 40 55                              |                                                             |                       |
| Zenith dist.                                               | 76 19 5                               |                                                             |                       |
| Co. lat.                                                   | 38 30 0                               | Co-sec.                                                     | 0,20585               |
| Polar dist.                                                | 96 54 51                              | Co-sec.                                                     | 0,00317               |
| Sum                                                        | 211 43 56                             |                                                             |                       |
| $\frac{1}{2}$ Sum                                          | 105 51 58                             | Log. sine                                                   | 9,98313               |
| Zenith dist.                                               | 76 19 5                               |                                                             |                       |
| Remainder                                                  | 29 32 53                              | Log. sine                                                   | 9,69298               |
| Sum                                                        |                                       | 2) 19,88513                                                 |                       |
| $\frac{1}{2}$ Sum = sine of $61^{\circ} 10' 34''$          | $\frac{1}{2}$ the H. angle =          | 9,94256                                                     |                       |
| Hour angle = $122^{\circ} 21' 8''$                         | 8h. 9m. 25s = time from last midnight |                                                             |                       |
| Time per watch                                             | 8 21 0                                |                                                             |                       |
| Watch too fast                                             | 11 35                                 |                                                             |                       |

As the time is before noon, the sine of half the sum of the logs. is taken and doubled, which gives the hour angle reckoned from the last



last midnight; for there seems to be no necessity for taking the co-sine of half the four logs. unless the observation be made in the afternoon; and the learner perhaps will be less liable to make mistakes.

The declination may be found thus:

The time per watch is 20 h. 21 m. from last noon the long. in time is 3 h. 28 m. which subtracted from 20 h. 21 m. leaves the apparent time 16 h. 53 m. the daily difference of declination is  $22' 44''$ . Now as  $24: 22' 44'' :: 16 53: 15' 59''$  which being added to the sun's declination Oct. the 9,  $= 6^{\circ} 38' 48''$  gives 6 hours 54 minutes 47 seconds, the true declination at the time and place of observation, whence the polar distance is  $96^{\circ} 54' 47''$ .

Here again it may be proper to observe, that as the day in the Nautical Almanac begins 12 hours later than the civil-day, and 24 hours later than the sea-day, 20 h. 21 m. makes 8 h. 21' or 21 m. after 8 in the morning of Oct. 10th of the civil-day, and 8 h. 21 m. A. M. Oct. 10th according to the sea account of time, therefore the end of the sea-day, the noon of the civil-day, and the beginning of the day in the Nautical Almanac are all at the same time.

*To find the apparent Time by the Altitude of a fixed Star.*

Correct the obs. altitude for the dip and refraction.

Find the ship's lat. by account at the time of observation.

Find the star's right ascension and declination in table XX.

Then add together

Zenith distance,

Co. latitude, and

Polar dist. into one sum.

From half this sum subtract the zenith dist. noting the half sum and remainder.

Then add together

Log. co-sec. of complement of the lat.

Log. co-sec. of polar distance,

Log. sine half the sum, and the

Log. sine remainder into one sum.

} rejecting their  
indexes.

Half the sum of these four logarithms will be the log. co-sine of half hour angle.

Turn this hour angle into time, and apply it to the star's right ascension, by subtracting it when the star is east of the meridian, or adding it when it is west of the meridian, their sum or difference will be the right ascension of the meridian or mid heaven.

From the right ascension of the meridian (increased by 24 if necessary) subtract the sun's right ascension the preceding noon at Greenwich, taken from page 2d of the month in the Nautical Almanac, the remainder will be the apparent time at ship nearly.

To

To this time apply the long. of the ship from Greenwich turned into time, by adding it when it is west, or subtracting it when it is east, the sum or difference will be the apparent time of the observation nearly by the meridian of Greenwich.

Then say, as 24 hours is to the daily variation of sun's right ascension, so is this time to a number of minutes and seconds, which subtracted from the above time, leaves the correct apparent time at ship.

## EXAMPLE I.

Suppose on Sept. 7th, 1796, in lat.  $7^{\circ} 45'$  south, and long.  $30^{\circ} 18'$  east of Greenwich, the alt. of the star Procyon, being then east of the meridian, should be  $28^{\circ} 16'$ , and the eye 18 feet above the surface of the sea. Required the true time?

|                               |                      |                |                      |
|-------------------------------|----------------------|----------------|----------------------|
| Star's obs. alt.              | $28^{\circ} 16' 0''$ | Lat. by acc.   | $7^{\circ} 45'$      |
| Refrac.                       | $1' 47''$            |                | $90$                 |
| Dip                           | $4 \ 3$              |                | $5 \ 50$             |
| Star's true alt.              | $28 \ 10 \ 10$       | Co. lat.       | $82 \ 15$            |
|                               | $90$                 | Star's decl.   | $5^{\circ} 44' 58''$ |
|                               |                      |                | $90$                 |
| Zen. dist.                    | $61 \ 49 \ 50$       | Polar dist.    | $95 \ 44 \ 58$       |
| Polar dist.                   | $95 \ 44 \ 58$       | Log. co-sec.   | $0,00219$            |
| Co. lat.                      | $82 \ 15 \ 0$        | Log. co-sec.   | $0,00398$            |
| Sum                           | $239 \ 49 \ 48$      |                |                      |
| Half sum                      | $119 \ 54 \ 54$      | Log. sine      | $9,93789$            |
| Zen. dist.                    | $61 \ 49 \ 50$       |                |                      |
| Remainder                     | $58 \ 5 \ 4$         | Log. sine      | $9,92881$            |
|                               |                      | Sum            | $2)19,87287$         |
| Half hour angle               | $30 \ 15$            | Half sum       | $9,93643$            |
|                               | $2$                  |                |                      |
| Hour angle                    | $60 \ 30 =$          | H. M. S.       |                      |
| Star's right ascension        |                      | $4 \ 2 \ 0$    |                      |
|                               |                      | $7 \ 28 \ 39$  |                      |
| Right ascension of meridian   |                      | $3 \ 26 \ 39$  |                      |
| Increased by                  |                      | $24$           |                      |
|                               |                      | $27 \ 26 \ 39$ |                      |
| Sun's right ascension at noon |                      | $11 \ 6 \ 37$  |                      |
| Time at ship nearly           |                      | $16 \ 20 \ 2$  |                      |

Time

|                                          |          |
|------------------------------------------|----------|
| Time at ship nearly                      | 16 20 2  |
| Ship's lon. $30^{\circ}18'$ east in time | 2 1 12   |
| Time at Greenwich nearly                 | 14 18 50 |
| Sun's right ascension, Sept. 7           | 11 6 37  |
| Ditto 8                                  | 11 10 13 |
| Daily difference                         | 3 36     |

Then say, as 24 H. : 3 M. 36 S. :: 14 H. 18 M. 50 S. : 2 M. 9 S.  
 which subtracted from 16 H. 20 M. 2 S. the time at ship nearly,  
 leaves 16 H. 17 M. 53 S. the true time at ship after noon, or 4 H. 17  
 M. 53 S. after midnight.

## EXAMPLE II.

Suppose on April 14, 1796, in lat.  $48^{\circ}56'$  N. long.  $66^{\circ}$  W. the  
 obs. alt. of Aldebaran, when west of the meridian, should be  $22^{\circ}$   
 $24' \frac{1}{2}$ , the height of the observer's eye 21 feet above the surface of  
 the sea. Required the true apparent time at ship?

|                                          |                  |                      |
|------------------------------------------|------------------|----------------------|
| Obs. Alt. Star Ald. $22^{\circ}24'30''$  | Lat. by acc.     | $48^{\circ}56'N.$    |
| Refrac. $2'18''$                         |                  | $90$                 |
| Dip 4 22                                 | 6 40             |                      |
| Star's true alt.                         | 22 17 50         | Co. lat. 41 4        |
|                                          | 90               | Star's decl. 16 5 19 |
| Zen. dist.                               | 67 42 10         | 90                   |
| Polar dist.                              | 73 54 41         | Polar dist. 73 54 41 |
| Co. lat.                                 | 41 4 0           | Log. co-sec. 0,01736 |
|                                          |                  | Log. co-sec. 0,18248 |
| Sum                                      | 2) 182 40 51     |                      |
| Half sum                                 | 91 20 25         | Sine 9,99988         |
| Zen. dist.                               | 67 42 10         |                      |
| Remainder                                | 23 38 15         | Sine 9,60309         |
|                                          |                  | Sum 2) 19,80281      |
| Half hour angle $37^{\circ}10'$ Co-fine. | Half sum 9,90140 |                      |
|                                          | 2                |                      |
| Hour angle                               | 74 20 = in time  | H. M. S. 4 57 20     |
|                                          | G g              | Hour                 |



|                                 |                 |         |
|---------------------------------|-----------------|---------|
| Hour angle                      | 74 20 = in time | 4 57 20 |
| Star's right ascension          |                 | 4 24 14 |
| Right ascension of meridian     |                 | 9 21 34 |
| Sun's right ascension           |                 | 1 33 30 |
| App. time at ship               |                 | 7 48 4  |
| Long. 66 W. in time             |                 | 4 24 0  |
| App. time at Greenwich          |                 | 12 12 4 |
| Sun's right ascension, April 14 |                 | 1 33 30 |
| Ditto 15                        |                 | 1 37 11 |
| Daily difference                |                 | 3 41    |

Then say, as 24 H. : 3 M. 41 S. :: 12 H. 12 M. 4 S. : 1 M. 52 S. which subtracted from 7 H. 48 M. 4 S. the apparent time at ship nearly, leaves 7 H. 46 M. 12 S. the correct app. time at ship.

NOTE. This method of finding the time is certain, could a good horizon be obtained in the night; but as that is not always the case, it is best to regulate the watch by the Sun.

*Another Method of finding the Apparent Time.*

RULE.

When the sun or star's declination, and complement of lat. are both north or both south, their sum \*, but if one be north and the other south, their difference is the meridian altitude.

From the natural sine of the sun or star's mer. alt. subtract the natural sine of the true altitude.

Then add together

The log. co-sec. of the comp. of the lat. } rejecting their  
The log. sec. of the sun or star's decl. and } indexes.  
The log. of the diff. of the natural sines into one sum.

The sum of these three logarithms, being found in the column of rising, the hours, minutes and seconds corresponding to it, will be the true time from the noon when the altitude was taken.

The four last examples may be worked by the above method.

\* If the sum exceeds 90° subtract it from 180, and the remainder will be the meridian altitude. (See the two last examples of the sun.)

## EXAMPLE I.

|          |           |                |         |
|----------|-----------|----------------|---------|
| Co. lat. | 50° 6' N. | Log. co-secant | 0,11511 |
| Decl.    | 17 11     | Log. secant    | 0,01983 |

|           |       |         |       |
|-----------|-------|---------|-------|
| Mer. alt. | 67 17 | N. fine | 92243 |
| True alt. | 15 54 | N. fine | 27396 |

Diff. of nat. fines 64847 Its log. 4,81189

In col. of rising gives true time 5 H. 33' 30" 4,94683  
Differing 2" from the former method.

## EXAMPLE II.

|          |            |                |         |
|----------|------------|----------------|---------|
| Co. lat. | 38° 30' N. | Log. co-secant | 0,20585 |
| Decl.    | 6 55 S.    | Log. secant    | 0,00317 |

|           |       |         |       |
|-----------|-------|---------|-------|
| Mer. alt. | 31 35 | N. fine | 52374 |
| True alt. | 13 41 | N. fine | 23656 |

Diff. of nat. fines 28718 Its log. 4,45815

In col. of rising gives true time 3 H. 50' 30" 4,66717

Here we find the time found by this method differs 2 seconds from that found by the former, but it may be found to the nearest second by taking proportional parts.

Thus, the difference between the log of 3 H. 50' 30" and 3 H. 51' is 172, and the difference between the log. of 3 H. 50' 30" and that in the calculation is 15.

Now as: 172 : 30" :: 15 : 2", which being added to 3 H. 50' 30" gives 3 H. 50' 32", (see the two last examples of the stars.)

## EXAMPLE III.

|          |         |        |         |
|----------|---------|--------|---------|
| Co. lat. | 82° 15' | Co-sec | 0,00398 |
| Decl.    | 5 45    | Sec.   | 0,00219 |

|           |       |         |       |
|-----------|-------|---------|-------|
| Mer. alt. | 76 30 | N. fine | 97237 |
| True alt. | 28 10 | N. fine | 47204 |

Diff. 50033 Its log. 4,69926

In col. of rising gives 4 H. 2 M. 4,70543

## EXAMPLE IV.

|           |           |         |                  |
|-----------|-----------|---------|------------------|
| Co. lat.  | 41° 4' 0" | Co-sec. | 0,18248          |
| Decl.     | 16 5 19   | Secant  | 0,01735          |
| Mer. alt. | 57 9 19   | N. sine | 84014            |
| True alt. | 22 17 50  | N. sine | 37933            |
| Diff.     |           | 46081   | Its log. 4,66346 |

In col. of rising gives 4 H. 57 M. 20 S.

Having found the hour angle, proceed to find the true time by the stars, as has been shewn in the two last examples, worked by the former method.

*How to know the Stars.*

It sometimes happens, that for want of a map of the stars, or a celestial globe, many are a loss to know whether they have observed by the right star or not, as there may some other stars come to the meridian nearly at the same time. But this may be easily proved, by finding the star's meridian altitude as above; and if it nearly agrees with that on the quadrant, it must certainly be the right star, otherwise not. The same may be observed of any of the planets.

To know when any star comes to the meridian, or what star will be on the meridian at any given time, see the explanation following, table XX. and for their rising and setting, with that of the moon and planets, see the directions following, table XXII. in this book.

NOTE 1. If an observation of the sun has not been taken the preceding noon, or two altitudes to find the latitude, it may be ascertained by taking the meridian altitude of the star, either before or after the observation is made for finding the time.

NOTE 2. If the ship's longitude east of Greenwich in time, be greater than the apparent time at the ship, the apparent time must be increased by 24 hours before subtracting the longitude; and in this case, the sun's right ascension must be taken out of the Ephemeris for the preceding day of the month. And if the ship's longitude west of Greenwich in time, added to the apparent time at the place of the ship, makes more than 24 hours, 24 must be subtracted from the sum, to obtain the apparent time at Greenwich; and the sun's right ascension must be taken out of the Ephemeris for the subsequent day of the month. The object, whether sun or star, whose altitude is taken for finding the time, must be at least three or four points of the compass distant from the meridian; because, when near to the meridian, the alteration in altitude is too slow for ascertaining the time with proper exactness: but the nearer the object is to the east or west the better, provided it be not less than



than  $6^{\circ}$  high ; for the refraction is so variable and irregular near to the horizon, that the effect of refraction upon objects cannot be determined with sufficient accuracy, when their altitudes are less than 6 degrees.

*The Method of finding the LONGITUDE at SEA.*

THE surprising improvements made in navigation within the last thirty years, is beyond the most sanguine expectation ; and though several nations have contributed towards this important end, the English have (by the encouragement given by parliament, and the great improvements made, in nautical instruments and calculations) outdone them all, so that, by the help of the improved sextant, the Nautical Almanac and the requisite tables, contained in this book, a skilful and expert observer can determine the longitude to a degree of certainty, that people unacquainted with the operation, would scarcely think it possible.

What is here meant by a skilful and expert observer, is, an artist who can in an instant bring the two limbs of the objects whose angular distance is to be measured into contact, in the centre of the inverted telescope, and, that can rectify any little defects, or errors that the instrument is liable to on account of its being handled or moved about, &c. To do which the following instructions may be found useful to the young artist.

1st. The instrument must be adjusted thus : bring  $\odot$  on the nonious to coincide with  $\odot$  on the arch, then see if the index glass stands perpendicular to the plane of the instrument, if it does not, alter it by means of the screws for that purpose ; after which, the reflected image of the sun must be brought directly over the true image, so that but one image appears ; this being done, which is by no means difficult, the instrument is properly adjusted, as the little speculum will stand parallel to the great one.

But to prove the instrument after this adjustment, and to find if there is any index error, move the index forward on the arch, and bring the true and reflected images of the sun's limbs into contact, and note what his diameter measures. Again, move the index backward on the part of the arch behind the  $\odot$ , and bring the reflected and true images of their limbs into contact as before, and note what his diameter measures ; half the difference between the two diameters is the index error, which must be subtracted when the diameter measures more on the arch than on the extra arch, otherwise it must be added.

Suppose, for example, the sun's diameter, measures when the index is advanced on the arch  $34'$ , and at the same time when the index is put back on the extra arch  $30'$ , the difference is  $4'$  then  $2'$  is the index error, which must be subtracted from all altitudes or angular

angular distance taken, because the sun's diameter measured more on the arch before  $\odot$  than behind it.

After the index error is found; yet before the instrument is fit to take the angular distance between any objects, there is another adjustment requisite, which is, to set the axis of the telescope parallel to the plane of the instrument.

The method of doing this, is, making observations of angles as much above  $90^\circ$  as possible, using the inverted telescope; in doing of which the wires in the focus of the eye-glass must be first placed parallel to the plane of the sextant, after which bring the sun and moon into very nice contact, on the centre of the wire nearest the sextant, taking care that the index is not the least moved, then direct the telescope in an instant so that the images may appear in the centre of the outer wire which is farthest from the sextant, and if the contact appear the same at this wire, the axis of the telescope is parallel to the plane of the sextant; on the contrary, if the limbs of the objects appear to separate at the wire which is farthest from the sextant, it is plain the object-end of the telescope is too far from the plane of the sextant, and must be corrected by turning one of the two screws of the ring into which the telescope is screwed and fixed, having previously unturned the other screw.

If the limbs of the images over-top each other at the aforesaid wire, it shews that the object-end of the telescope is too near the plane of the instrument, and consequently must be brought parallel, by means of the screws, and this method must be pursued until the distance of objects are found perfectly the same, at each wire, which stands equi-distant from the centre of the telescope and parallel to each other, in which case the axis of the telescope will be exactly parallel to the plane of the sextant, and then you may proceed to measure the angles for the observations, observing to bring the limbs of the objects in exact contact, in the centre between the two wires before-mentioned.

*To take the Observations requisite for determining the Longitude.*

First, find the apparent time at the place of observation, by taking one or more altitudes of the sun, and noting the times by a good watch, from each observed altitude, or, from the mean of several altitudes compute the time; the difference between this time and that by the watch, will shew how much the watch is too fast or too slow, for in all cases the mean of several observations is most to be depended on, and the best time for making these observations of the sun's altitude is, when it changes quickest, or when he bears nearly east or west.

In observing the distance between the objects three observers must be in readiness with their sextants or quadrants, well adjusted, as before directed; and, the watch either suspended near one of the observers,

observers, or put into the hands of a fourth person appointed to note the times. The observer who takes the angular distance giving previous notice to the others to be ready with the altitude by the time he has finished his observation, which being done, the time, altitude and distance should be carefully noted; and other sets of observations taken, which must be done within the space of 15 minutes, and then take the means, which will be preferable to any single observation. In taking the altitude of the moon the limb that is the best defined whether it be the upper or lower, must be brought to the horizon; if there are not a sufficient number of observers, then take the altitudes, the deficiency may be supplied by computing the altitudes after the distance is taken; the method of doing it will be shewn hereafter.

*To Measure the Distance between the Sun and Moon.*

Turn down one of the screws and hold the quadrant or sextant, so that its plane shall pass through the sun and moon; look at the moon through the transparent part of the horizon glass; and keeping her there, move the index gently until the sun's image is brought into the silvered part of the horizon glass, bring the nearest limbs of both objects into contact; move the arch of the instrument gently up and down, and the sun will appear to rise and fall by the side of the moon. Move the index until their limbs exactly touch each other, when this is done the observation is made, and the index will shew the angular distance, which is best read off by a magnifying glass.

*To take the Distance between the Moon and a Star.*

Direct the plane of the instrument through both objects, look at the star through the bright part of the horizon glass; keep it there, and bring the moon's image into the silvered part of the same glass; move the index gently, until the enlightened limb of the moon just touches the centre of the star, keep the star in sight, and move the arch of the instrument gently up and down, and the moon will appear to pass over the star, and then the observation is completed.

The round or well defined limb of the moon, whether it be the nearest or farthest from the star, must be brought into contact with it. When the object to be seen by reflection is to the right-hand of that seen directly, the instrument is held with its face upward. But when the object to be seen by reflection, is to the left-hand of that seen directly, the instrument is held with its face downward.

A readiness in the use of the quadrant and sextant, is best gained by practice which the learner may render familiar to himself by observing



observing the angular distance of objects on land, or by candles placed in various positions in a room.

Remark 1st. The taking the angular distance may be rendered more easy and accurate, by bringing the objects nearly into contact in the common way, and then fixing the index tight to a certain degree and minute, and then waiting until the objects are nearly in contact; giving notice to the assistants to get ready with the altitudes, and when the objects are exactly in contact to call for the altitudes and exact time by the watch. The observer may then prepare for taking another distance, by setting his index three or four minutes forwards or backwards according as the objects are approaching to, or receding from each other, and then proceed to take the distance, the altitudes and time by the watch as before. Thus may as many distances and altitudes be taken as the observers think proper, and then take the means to determine his longitude by.

This mode of taking the distance, will not only ease the eye of the observer, but also enable him to manage his instrument with greater facility in every direction. If the observation be made, as it ought to be, at the distance of two hours before or after noon, the true time may be found by the altitude of the sun, taken at the precise time of taking the distance, thus will any irregularity in the going of the watch, be prevented from affecting the result of the observations.

If a night observation is to be taken, the watch should be regulated by the altitude of the sun the evening before, and its going compared with another taken the next morning, for the time found by the altitude of a star cannot so well be depended on, as the atmosphere in the night is precarious, though it may be sufficiently correct for finding the refraction used in determining the angular distance.

Remark 2d. The observer must take the moon's distance from those stars only, whose distance from her are set down in the Nautical Almanac, and the distances there set down afford him a ready means of knowing the star from which her distance ought to be observed: by setting his index to the distance computed roughly at the apparent time, estimated nearly for the meridian of Greenwich, and then look to the east or west of the moon, according as the distance of the star is set down in the 8th, 9th, 10th, or 11th pages of the month in the Nautical Almanac, and having found the moon on the horizon-glass he will, by sweeping with the quadrant or sextant, to the right, or left, find the star he wants, if above the horizon, and the air be clear, in a line, perpendicular to that joining the moon's horns or her shortest axis produced.

The time at Greenwich is estimated roughly by turning the ship's supposed longitude from Greenwich into time, and adding it

it to, or subtracting it from the apparent time at the ship, according as the longitude is east or west, will give the apparent time nearly at Greenwich.

Take the distance of the object, out of the Nautical Almanac both before and after this time;

Then say, as 3 hours or 180 minutes : is the difference of distance in 3 hours : : so is the difference between this nearly estimated time, and the next preceding time set down in the Nautical Almanac : to a number of minutes ; which being added to the next preceding distance, if it is increasing, or subtracting it, if it is decreasing, will give the distance nearly at the time the observation is intended to be made, and, to which the index of the sextant or quadrant must be set.

Care must be taken not to confound the days in the Nautical Almanac with the civil days, as the civil day begins 12 hours before it, nor with the sea day which begins 24 hours before it.

*To Reduce the observed Distance of the Moon from the Sun, or a Star to the true Distance.*

The necessary preparations :

**T**URN the longitude into time, and add it to the apparent time at the ship, if it be west, but subtract it if it be east ; the sum, or difference will be the supposed time at Greenwich, which call reduced time.

In page 7th of the month in the Nautical Almanac, find the nearest noon or midnight, both before and after the reduced time.

Take out the moon's semidiameters and horizontal parallaxes corresponding with this noon and midnight, and find their differences.

Then say, as 12 hours : is to the difference of the moon's horizontal parallax in 12 hours : : so is the reduced time to a fourth number, which being added to the moon's horizontal parallax for noon or midnight, if it is increasing, but if decreasing subtracted from it ; this sum, or difference, will be the moon's horizontal parallax at the reduced time.

And, as 12 hours : is to the difference of the moon's semidiameter in 12 hours : : so is the reduced time to a number of seconds, which being added to, or subtracted from the moon's semidiameter the noon or midnight before the reduced time, will give the moon's semidiameter at the reduced time.

To which add the augmentation of her semidiameter according to her altitude, and the sum will be the moon's true apparent semidiameter. When the reduced time is any even part of 12 hours, as,  $\frac{1}{2}$   $\frac{1}{3}$   $\frac{1}{4}$  or  $\frac{2}{3}$ , &c. such parts of the difference of the semidiameter and horizontal parallax may be taken and added, to, or subtracted as

H h

above,

above, without being at the trouble of working by the Rule of Three.

To the observed altitude of the sun's lower limb, add the difference between his semidiameter and the dip of horizon, the sum will be his apparent altitude.

From the sun's refraction, take his parallax in altitude, the remainder will be the *correction of the sun's altitude*.

From the star's observed altitude take the dip of the horizon, and the remainder will be its apparent altitude.

The refraction is the *correction of the star's altitude*.

Take the difference between the moon's semidiameter and the dip and add it to the observed altitude, if her lower limb was taken, or subtract it, if upper limb was taken, the sum, or difference, will be the moon's apparent altitude.

From the proportional logarithm of the moon's horizontal parallax, found in the Nautical Almanac, (increasing its index by 10) take the logarithm co-sine of the moon's apparent altitude, the remainder will be the proportional logarithm of her parallax, in altitude. From which, take his refraction, and the remainder *will be the correction of the moon's altitude*.

To the observed distance of the moon from a star, add the moon's semidiameter, if her nearest limb was taken, but subtract it, if her farthest limb was taken, the sum, or difference, will be the apparent distance. But,

To the observed distance of the sun and moon's nearest limbs, add both their semidiameters and the sum will be the apparent distance of their centers.

NOTE. There are 12 pages in each month in the Nautical Almanac.

|                                              |                  |
|----------------------------------------------|------------------|
| The sun's declination is found in page       | II.              |
| The sun's semidiameter in                    | III.             |
| The moon's semidiam. and horizontal parallax | VII.             |
| The distance of the moon from the sun, &c.   | VIII. IX. X. XI. |

#### The Tables in this Book.

|                                                |           |
|------------------------------------------------|-----------|
| The proportional logarithms                    | Table IX. |
| The effect of parallax, on the moon's distance | X.        |
| To turn time into degrees, and the contrary    | XI.       |
| Refraction of the heavenly bodies              | XII.      |
| Dip of the horizon                             | XIII.     |
| The sun's parallax in altitude                 | XIV.      |
| The augmentation of the moon's semidiameter    | XV.       |
| To correct the sun's decl. under any meridian. | XVIII.    |

Having



*Having the Apparent Altitudes of the Objects, and their Apparent Distance, to find their true Distance.*

1st. Add together

THE proportional logarithm of the correction of the sun's or star's altitude,

The log. co-sine of the sun or star's apparent altitude,

The log. sine of the apparent distance,

The log. co-secant of the moon's apparent altitude,

Their sum, (rejecting 30 in the index) will be the proportional logarithm of the first arch :

2dly. Add together

The proportional log. of the correction of the sun or star's altitude,

The log. co-tangent of the sun or star's apparent altitude,

The log. tangent of the apparent distance,

Their sum (rejecting 20 in the index) will be the proportional logarithm of the second arch :

Take the difference between the first and second arches, and add it to the appa. dist. if less than  $90^{\circ}$ ; and the first arch be greater than the second, but if it be less subtract it ;

But, if the dist. be more than  $90^{\circ}$ , the sum of the arches added to the appa. dist. will give the dist. corrected for the refraction of the sun or star.

3dly. Add together

The proportional logarithm of the correction of the moon's altitude,

The log. co-sine of the moon's apparent altitude,

The log. sine of the distance corrected for the sun or star's refraction ;

The log. co-secant of the sun or star's apparent altitude :

Their sum (rejecting 30 in the index) will be the proportional logarithm of the third arch.

4thly. Add together

The proportional log. of the correction of the moon's appa. altitude,

The log. co-tangent of the moon's apparent altitude,

The log. tang. of the dist. corrected for the sun or star's refraction ;

Their sum (rejecting 20 in the index) will be the proportional logarithm of the fourth arch.

Take the difference between the third and fourth arches, and subtract it from the distance corrected for the sun or star's refraction, if less than  $90$ , and the third arch be greater than the fourth ; or, add it to the distance corrected, if the fourth arch be greater than the third ; But, if the distance be more than  $90^{\circ}$ , the sum of both arches must be subtracted from it ; and the sum or difference will be the distance corrected for the sun or star's refraction, and the principal effect of the moon's parallax.

In table X. look for this last corrected distance in the top column, and the correction of the moon's altitude in the left-hand-side column ; take out the number of seconds that stand under the former and opposite to the latter.

H h 2

Look

Look again in the same table for the corrected distance in the top column, and the principal effect of the moon's parallax in the lefthand-side column, and take out the number of seconds that stand under the former and opposite the latter. The difference between these two numbers must be added to the corrected distance if less than  $90^\circ$ , but subtracted from it if more than  $90^\circ$ ;

The sum, or difference, will be the true distance.

*Having the true Distance and Time to determine the Longitude.*

IN the Nautical Almanac, among the distances of the objects, look for the computed distance between the moon and the other object observed on the given day, if it is found there, the time at Greenwich will be at the top of the column, but if it falls between two distances, as it generally will, take the difference between the distances that stand immediately before and after the computed distance, and also the difference between the distance standing before it and the computed distance.

Then take the proportional logarithm of the first difference, which is the difference in three hours, and the proportional logarithm of the second difference, which is the difference between the computed distance and the distance before it.

The difference between these two logarithms will be the proportional logarithm of a number of hours, minutes, and seconds, which being added to the time standing over the first distance in the Nautical Almanac, will give the true time at Greenwich.

The difference between Green. time and that at the ship turned into longitude, will be the longitude in, at the time the observations were made, which will be east if the time at the ship be greater than that at Greenwich, but if it be less, the longitude will be west.

Or the proportional part of time may be found by saying;

As the first difference : is to 3 hours :: so is the second difference : to a proportional part of time, which being added as above directed, will give the true time at Greenwich.

The foregoing rules will be rendered easy by the following examples, which are only here supposed, but will answer the purpose of instructing the learner as well as if the altitudes and distances had been actually taken.

NOTE. In working the following examples, it will save some time, if all the logarithmic sines, tangents, secants, and proportional logarithms, which fall at the same opening of the book, be taken out at the same time, both in the first and second parts of the operation.

Thus, the co-sine and co-tangent of the star's apparent altitude, and co-secant of its altitude may all be taken out at the same time, and written down in different parts of the paper, (or in a formula) and so may the co-sine, co-tangent, and co-secant of the moon's apparent altitude, the sine and tangent of the apparent distance and the sine and tangent of the distance corrected, for the refraction of the sun or star.

In order to shorten the following work,  $\odot$  signifies the sun;  $\textcircled{m}$  the moon;  $*$  a star; P. L. proportional logarithm; L. L. lower limb; Up. L. upper limb; Hor. P. horizontal parallax; N. A. Nautical Almanac.

E X A M P L E

## EXAMPLE I.

Suppose on Jan. 30, 1796, in long.  $11^{\circ}$  E. by account, at 10 h. 15' P.M. per watch, the distance of the moon's farthest limb from the star Regulus was  $63^{\circ}50'20''$ , when the alt. of the moon's lower limb was  $24^{\circ}18'40''$ , and the star's  $45^{\circ}13'4''$ , the eye being 18 feet above the surface of the sea: required the true longitude?

| H. M. S.                              |                        |                                                      |                                 |                         |         |
|---------------------------------------|------------------------|------------------------------------------------------|---------------------------------|-------------------------|---------|
| Time per watch                        | 10 15 00               | ☾'s semid. at noon                                   | 15' 3"                          | Hor. par.               | 55' 14" |
| Long. $11^{\circ}$ in T.              | 0 44 00                | Ditto at midnight                                    | 14 59                           | Hor. par.               | 54 59   |
| Reduced time                          | 9 <sup>h</sup> 31' 00" | Diff. in 12 hours                                    | 4                               | Diff. in 12 hours       | 15      |
| ☾'s alt.                              | 24 18 40               | as 12:4" :: 9:3" and as 12:15" :: 9:12" the P. parts |                                 |                         |         |
| Sem. 15' 7"                           | 0 11 4                 | ☾'s sem. at N. 15' 3                                 | Hor. par. at noon               | 55 14                   |         |
| Dip 4 3                               |                        |                                                      |                                 |                         |         |
| App. alt.                             | 24 29 44               | Ditto at red. t. 15 0                                | Ditto at red. time 55 2         | P. L. 10,5146           |         |
|                                       |                        | Augmentation 7                                       | ☾'s ap. al. $24^{\circ}29'44''$ | L. cos. 9,9590          |         |
| ☾'s true semidiameter                 |                        | 15 7                                                 | ☾'s par. in alt. 50' 5"         | 0,5556                  |         |
| *'s Obs. alt.                         |                        | 45 <sup>h</sup> 13 15                                | ☾'s refraction 2 5              |                         |         |
| Dip                                   |                        | 4 3                                                  |                                 |                         |         |
| *'s app. altitude                     |                        | 45 9 12                                              | Cor. of ☾'s alt. 48 0           |                         |         |
| *'s refraction 57" is its correction. |                        |                                                      | Observed distance               | 63 <sup>h</sup> 50' 20" |         |
|                                       |                        |                                                      | ☾'s semidiameter                | 0 15 7                  |         |
|                                       |                        |                                                      | App. dist. of ☾ and *           | 63 35 13                |         |

## To find the Distance.

|                                       |                      |                                                         |                                         |               |         |
|---------------------------------------|----------------------|---------------------------------------------------------|-----------------------------------------|---------------|---------|
| Cor. of *'s alt.                      | 57"                  | Pr. log.                                                | 2,2775                                  | P. L.         | 2,2775  |
| *'s app. alt.                         | 45 <sup>h</sup> 9' 0 | Log. cos.                                               | 9,8483                                  | Co-tang.      | 9,9977  |
| App. dist.                            | 63 35 0              | Log. sine                                               | 9,9521                                  | Tang.         | 10,3038 |
| *'s app. alt.                         | 24 30 0              | L. co-sec.                                              | 10,3822                                 |               |         |
| Reject 30 1st cor.                    | 37 = P. L.           | 2,4601                                                  | Reject 20, 2d Cor. 29" P. L. = 2,5790   |               |         |
|                                       |                      |                                                         | 1st Cor. 37                             |               |         |
|                                       |                      | Diff. 1st and 2d cor.                                   | 8                                       |               |         |
|                                       |                      | App. dist.                                              | 63 35 13                                |               |         |
| Distance corrected for *'s refraction |                      |                                                         | 63 35 21                                |               |         |
| Cor. of ☾'s alt.                      | 48 40                | Pr. log.                                                | 0,5740                                  | P. L.         | 0,5740  |
| ☾'s alt.                              | 24 30 0              | Log. cos.                                               | 9,9590                                  | Log. co-tang. | 10,3413 |
| Cor. dist.                            | 63 35 0              | Log. sine                                               | 9,9521                                  | Log. tang.    | 10,3038 |
| *'s alt.                              | 45 9 0               | Co. sec.                                                | 10,1493                                 |               |         |
| Reject 30 = 3d cor. 41 46             | P. L. = 0,6344       |                                                         | Reject 20 4th cor. 10' 52" P. L. 1,2191 |               |         |
|                                       |                      |                                                         | 3d cor. 41 46                           |               |         |
|                                       |                      | Principal effect of ☾'s parallax                        | 30 54                                   |               |         |
|                                       |                      | Corrected distance                                      | 63 35 21                                |               |         |
| Cor. tab. X. gives                    | 9                    |                                                         |                                         |               |         |
| Second in ditto gives                 | 4                    | Diff. cor. for princ. effect                            |                                         |               |         |
|                                       |                      | of refr. and par.                                       | 63 4 27                                 |               |         |
|                                       |                      | 5 Difference to be added                                | 5                                       |               |         |
|                                       |                      | True distance                                           | 63 4 32                                 |               |         |
| By the Ephemeris,                     | 1st dist. at 9 h.    | 62 <sup>h</sup> 49' 15"                                 | Dist. at 9 h.                           | 62 49 15      |         |
| Jan. 30, 1796,                        | Ditto at 12          | 64 19 56                                                |                                         |               |         |
|                                       |                      | 1st diff.                                               | 0 15 17                                 | P. L. 1,0710  |         |
|                                       |                      | 2d diff.                                                | 1 30 41                                 | P. L. 0,2977  |         |
|                                       |                      |                                                         |                                         |               |         |
|                                       | H. M. S.             |                                                         |                                         |               |         |
| Time standing over 1st dist.          | 9 0 0                | Diff. of T. bet. Sh. and Gr.                            | 30 20                                   | P. L. 0,7733  |         |
| Diff. of time                         | 30 20                |                                                         |                                         |               |         |
|                                       | 9 30 20              | Now 44' 40" turned into long. gives $11^{\circ}10'00''$ |                                         |               |         |
| Time at ship                          | 10 15 0              | and it is E. because the time at the ship is more       |                                         |               |         |
|                                       |                      | than that at Greenwich.                                 |                                         |               |         |
| Diff. of T. betw. sh. and Gr.         | 44 40"               |                                                         |                                         |               |         |



## EXAMPLE II.

Suppose that on the 31st of May, 1796, a ship at sea in long.  $23^{\circ}$  east of Greenwich by account, at 5 hours 36 minutes in the afternoon by a watch well regulated, the distance of the sun and moon's nearest limbs should be observed to be  $68^{\circ} 10' M. 24$  S. at the same time the altitude of the sun's lower limb was  $31^{\circ} 48' M. 3$ , and that of the moon's lower limb  $23^{\circ} 48' M. 3$ , the eye being 18 feet above the surface of the sea, and the ship's true longitude be required?

|                              |                       |                                                           |       |                      |                       |
|------------------------------|-----------------------|-----------------------------------------------------------|-------|----------------------|-----------------------|
| Time per watch               | 5 36                  | ☽'s semi-diam. at noon                                    | 15 49 | Hor. paral.          | 58 1                  |
| Long. $23^{\circ}$ E. in Ti. | 1 32                  | Ditto at midnight                                         | 15 56 | Ditto                | 58 29                 |
| Reduced time                 | 4 4                   | Diff. in 12 hours                                         | 7     | Diff.                | 28"                   |
| ☉'s obs. alt                 | $31^{\circ} 48' 15''$ | Now as 12h. : 7" :: 4h. : 2" and as 12h. : 28" :: 4h. : 9 |       |                      |                       |
| Semidi.                      | $15' 49''$            |                                                           |       |                      |                       |
| Dip                          | 4 3                   | Diff.                                                     | 11 46 | Semidiam. at noon    | 15 49                 |
| ☉'s app. alt.                | 32 0 1                | Semidi. at red. time                                      | 15 51 | Hor. par. at red. T. | 58 10                 |
| Ref. $1' 31''$ —par. 8=      |                       | Augmentation                                              | 7     | Obs. dist.           | $68^{\circ} 10' 24''$ |
| Cor. ☉'s al.                 | $1' 23''$             |                                                           |       |                      |                       |

|                |       |     |  |  |       |
|----------------|-------|-----|--|--|-------|
| ☽'s semi-diam. | 15 58 |     |  |  |       |
| ☉'s ditto      | 15 49 | Sum |  |  | 31 47 |

|               |         |         |         |                                |          |
|---------------|---------|---------|---------|--------------------------------|----------|
| ☽'s hor. par. | 58 10   | P. L.   | 10,4906 |                                |          |
| ☽'s app. alt. | 24 0 10 | L. cof. | 9,9607  | Ap. dist. of ☉'s & ☽'s centres | 68 42 11 |

|                  |      |       |      |                                        |          |
|------------------|------|-------|------|----------------------------------------|----------|
| ☽'s par. in alt. | 53 8 | P. L. | 5299 | ☽'s obs. alt.                          | 23 48 15 |
| Refract.         | 2 7  |       |      | Semidi. $15' 58''$ —dip $4' 3''$ diff. | 11 55    |

|               |      |               |  |  |          |
|---------------|------|---------------|--|--|----------|
| Cor. ☽'s alt. | 51 1 | ☽'s app. alt. |  |  | 24 00 10 |
|---------------|------|---------------|--|--|----------|

|                  |         |           |        |         |          |         |
|------------------|---------|-----------|--------|---------|----------|---------|
| Cor. of ☉'s alt. | 0 1 23  | P. L.     | 2,1143 | 0 1 23  | P. L.    | 2,1143  |
| ☉'s app. alt.    | 32 0 0  | L. co-fi. | 9,9284 | 32 0 0  | Co. tan. | 10,2042 |
| App. dist.       | 68 42 0 | L. sin.   | 9,9692 | 68 42 0 | Tan.     | 10,4090 |

|               |        |            |         |                            |  |        |
|---------------|--------|------------|---------|----------------------------|--|--------|
| ☽'s app. alt. | 24 0 0 | L. co-sec. | 10,3907 | Reject 20 P. L. 2d an. 20" |  | 2,7875 |
|---------------|--------|------------|---------|----------------------------|--|--------|

|                          |           |        |             |    |  |  |
|--------------------------|-----------|--------|-------------|----|--|--|
| Reject 30=1st an. $43''$ | Pro. log. | 2,4026 | First angle | 43 |  |  |
|--------------------------|-----------|--------|-------------|----|--|--|

|            |                       |  |  |  |  |  |
|------------|-----------------------|--|--|--|--|--|
| Difference | 23                    |  |  |  |  |  |
| App. dist. | $68^{\circ} 42' 11''$ |  |  |  |  |  |

|                                                  |  |  |  |          |  |  |
|--------------------------------------------------|--|--|--|----------|--|--|
| Dist. corrected for principal effect of ☉'s ref. |  |  |  | 68 42 34 |  |  |
|--------------------------------------------------|--|--|--|----------|--|--|

|                  |           |       |        |           |       |        |
|------------------|-----------|-------|--------|-----------|-------|--------|
| Cor. of ☽'s alt. | $51' 1''$ | P. L. | 0,5475 | $51' 1''$ | P. L. | 0,5475 |
|------------------|-----------|-------|--------|-----------|-------|--------|

|               |                     |         |        |                     |          |         |
|---------------|---------------------|---------|--------|---------------------|----------|---------|
| ☽'s app. alt. | $24^{\circ} 0' 0''$ | L. cof. | 9,9607 | $24^{\circ} 0' 0''$ | C. tang. | 10,3514 |
|---------------|---------------------|---------|--------|---------------------|----------|---------|

|             |          |         |        |          |      |         |
|-------------|----------|---------|--------|----------|------|---------|
| Dist. corr. | 68 42 34 | E. fine | 9,9692 | 68 42 34 | Tan. | 10,4090 |
|-------------|----------|---------|--------|----------|------|---------|

|               |        |            |         |  |  |        |
|---------------|--------|------------|---------|--|--|--------|
| ☉'s app. alt. | 32 0 0 | L. co. fe. | 10,2758 |  |  | 1,3081 |
|---------------|--------|------------|---------|--|--|--------|

|                           |            |      |        |            |  |  |
|---------------------------|------------|------|--------|------------|--|--|
| Reject 30 P. L. of 3d an. | $31' 46''$ | 7533 | 3d an. | $31' 46''$ |  |  |
|---------------------------|------------|------|--------|------------|--|--|

|                         |    |  |  |  |  |  |
|-------------------------|----|--|--|--|--|--|
| Cor. from tab. X. gives | 8" |  |  |  |  |  |
|-------------------------|----|--|--|--|--|--|

|                       |   |                           |       |  |  |  |
|-----------------------|---|---------------------------|-------|--|--|--|
| Cor. from ditto gives | 1 | Principal effect of para. | 22 55 |  |  |  |
|-----------------------|---|---------------------------|-------|--|--|--|

|                      |   |                                         |          |  |  |  |
|----------------------|---|-----------------------------------------|----------|--|--|--|
| Diff. of corrections | 7 | Diff. cor. for princ eff. of ref. & pa. | 68 42 34 |  |  |  |
|----------------------|---|-----------------------------------------|----------|--|--|--|

|               |          |  |  |  |  |  |
|---------------|----------|--|--|--|--|--|
| 2d cor. dist. | 68 19 39 |  |  |  |  |  |
| Correction    | 7        |  |  |  |  |  |

|                                   |  |            |          |  |  |  |
|-----------------------------------|--|------------|----------|--|--|--|
| By the Ephemeris for May 31, 1796 |  | True dist. | 68 19 46 |  |  |  |
|-----------------------------------|--|------------|----------|--|--|--|

|                     |                       |                 |                       |  |  |  |
|---------------------|-----------------------|-----------------|-----------------------|--|--|--|
| First dist. at 3 h. | $68^{\circ} 57' 44''$ | Ditto at 3 hour | $68^{\circ} 57' 44''$ |  |  |  |
|---------------------|-----------------------|-----------------|-----------------------|--|--|--|

|                      |                       |                |                       |  |  |  |
|----------------------|-----------------------|----------------|-----------------------|--|--|--|
| Second dist. at 6 h. | $67^{\circ} 23' 15''$ | Computed dist. | $68^{\circ} 19' 46''$ |  |  |  |
|----------------------|-----------------------|----------------|-----------------------|--|--|--|

|                  |         |       |        |  |  |       |
|------------------|---------|-------|--------|--|--|-------|
| Diff. in 3 hours | 1 34 29 | P. L. | 0,2799 |  |  | 37 58 |
|------------------|---------|-------|--------|--|--|-------|

|                |       |       |        |  |  |  |
|----------------|-------|-------|--------|--|--|--|
| Computed diff. | 37 58 | P. L. | 0,6759 |  |  |  |
|----------------|-------|-------|--------|--|--|--|

|          |  |  |  |  |  |  |
|----------|--|--|--|--|--|--|
| H. M. S. |  |  |  |  |  |  |
|----------|--|--|--|--|--|--|

|               |         |  |      |  |  |  |
|---------------|---------|--|------|--|--|--|
| Prop. log. of | 1 12 19 |  | 3960 |  |  |  |
|---------------|---------|--|------|--|--|--|

|                   |   |          |  |  |  |  |
|-------------------|---|----------|--|--|--|--|
| T. over 1st dist. | 3 | H. M. S. |  |  |  |  |
|-------------------|---|----------|--|--|--|--|

|                 |         |         |                                                                                                    |  |  |  |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------|--|--|--|
| T. at Greenwich | 4 12 19 | 1 23 41 | the diff. of time between the ship and Greenwich, being brought into long. by allowing 15 degrees, |  |  |  |
|-----------------|---------|---------|----------------------------------------------------------------------------------------------------|--|--|--|

|            |        |                                                                                                             |  |  |  |  |
|------------|--------|-------------------------------------------------------------------------------------------------------------|--|--|--|--|
| T. at ship | 5 36 0 | &c. for every hour, briefly by table XI. gives $55' 15''$ the long. in; and it is east, because the time at |  |  |  |  |
|------------|--------|-------------------------------------------------------------------------------------------------------------|--|--|--|--|

|  |         |                                     |  |  |  |  |
|--|---------|-------------------------------------|--|--|--|--|
|  | 1 23 41 | the ship is more than at Greenwich, |  |  |  |  |
|--|---------|-------------------------------------|--|--|--|--|

# THE LONGITUDE AT SEA.

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## EXAMPLE III.

Suppose that on the 20th of Nov. 1796, a ship at sea, in long.  $9^{\circ}$  west of Greenwich by account at 6 H. 10 M. P. M. per watch well regulated, the distance of the  $\odot$ 's and  $\uparrow$ 's nearest limbs should be observed  $102^{\circ} 57' \frac{1}{2}$ , when the alt. of the  $\odot$ 's lower limb was  $18^{\circ} 47' \frac{1}{2}$ , and that of the  $\uparrow$ 's lower limb  $70^{\circ} 32'$ , the eye being 20 feet above the sea, and the longitude be required?

|                                                 | H. M.         |                       | M. S.                          |                                  |                  |
|-------------------------------------------------|---------------|-----------------------|--------------------------------|----------------------------------|------------------|
| Time per watch                                  | 6 10          | $\uparrow$ 's sem. n. | 16 11                          | Hor. Par. n.                     | 59 25            |
| Long. $9^{\circ}$ W                             | 36            | Ditto at m.           | 16 6                           | Ditto at m.                      | 59 5             |
| Red. time                                       | 6 46          |                       |                                | 5 P. part 3                      | 20 P. part 11"   |
|                                                 |               |                       |                                | 16 11                            |                  |
|                                                 |               |                       |                                | 16 8                             | Hor. par. 59 25" |
| $\uparrow$ 's obs. alt.                         | 70° 32' 0"    | Ang.                  | 15                             | Hor. p. red. time                | 59 14"           |
| Sem. 16' 23" Dip 4' 16"                         | 0 12 7        |                       |                                |                                  |                  |
| $\uparrow$ 's app. alt.                         | 70 44 7       | Sem. red. ti.         | 16 23                          |                                  |                  |
|                                                 |               | $\odot$ 's sem.       | 16 15                          | Sum                              | 0 32 38          |
|                                                 |               | Obs. dist.            |                                |                                  | 102 57 30        |
| $\uparrow$ 's hor. par.                         | M. S. 59 14   | P. log.               | 10,4827                        | App. dist. of cent.              | 103 30 8         |
| $\uparrow$ 's app. alt.                         | 70 44 0       | co-f.                 | 9,5184                         | $\odot$ 's obs. alt.             | 18 47 30         |
|                                                 |               |                       |                                | Sem. 16" 15"—dip 4" 16" =        | 11 59            |
| $\uparrow$ 's P. in alt.                        | 19 33         | P. log.               | 9643                           | $\odot$ 's app. alt.             | 18 59 29         |
| Ref.                                            | 19            | Ref. 2' 44"           |                                | Par. 8" = 2" 36" $\odot$ 's cor. |                  |
| Cor. $\uparrow$ 's alt.                         | 19 14         |                       |                                |                                  |                  |
| Cor. of $\odot$ 's alt.                         | 0° 2' 36"     | P. log.               | 1,8403                         | P. log.                          | 1,8403           |
| $\odot$ 's alt.                                 | 18 59 0       | Co-f.                 | 9,9757                         | Co-t.                            | 10,4634          |
| App. dist.                                      | 103 30 0      | S.                    | 9,9878                         | T.                               | 10,6196          |
| $\uparrow$ 's alt.                              | 70 44 0       | Co-se.                | 10,0250                        |                                  |                  |
|                                                 |               |                       |                                | Reject 20 P. log. 2d ang. 13"    | 2,9233           |
| Reject 30 Pro. log. 1st Ang. 2' 40"             |               | 1,8288                | Pro. log. 1st ang.             | 2 40                             |                  |
|                                                 |               |                       | Sum                            | 2 53                             |                  |
|                                                 |               |                       | App. dist.                     | 103 30 8                         |                  |
|                                                 |               |                       | Dist. cor. for $\odot$ 's ref. | 103 33 1                         |                  |
| Cor. $\uparrow$ 's alt.                         | 19' 14"       | P. L.                 | 0,9712                         | P. L.                            | 0,9712           |
| $\uparrow$ 's ap. alt.                          | 70° 44        | Co-fine               | 9,5184                         | Co-t.                            | 9,5435           |
| Dist. cor.                                      | 103 33        | Sine                  | 9,9877                         | T.                               | 10,6179          |
| $\odot$ 's alt.                                 | 18 59         | Co-se.                | 10,4877                        |                                  |                  |
|                                                 |               |                       |                                | Reject 20 P. L. 4th ang. 13' 16" | 1,1326           |
| Reject 30 P. log. 3d ang. 19' 30"               |               | 0,9650                | P. L. 3d ang.                  | 19 30                            |                  |
|                                                 |               |                       | Prin. eff. of para.            | 32 46                            |                  |
|                                                 |               |                       | Dist. cor.                     | 103 33 1                         |                  |
|                                                 |               |                       |                                | 103 0 15                         |                  |
| Dist. cor. for the prin. eff. of para. and ref. |               |                       |                                |                                  |                  |
| 1st Cor. Table X.                               | 0             |                       |                                |                                  |                  |
| 2d Cor. ditto                                   | 2 Diff.       |                       |                                |                                  |                  |
| Dist. at 6 h.                                   | 103 24 28     |                       |                                |                                  |                  |
| Dist. at 9                                      | 101 46 52     |                       |                                |                                  |                  |
|                                                 |               | True dist.            | 103 0 13                       |                                  |                  |
|                                                 |               | Dist. at 6 h.         | 103 24 28                      |                                  |                  |
|                                                 |               | 2d Diff.              | 24 15 P. L. 8706               |                                  |                  |
| 1st Diff.                                       | 1 37 36 P. L. |                       | 2658                           |                                  |                  |
| Diff. of time between ship and Greenwich        | 44 43         |                       | P. L. 6048                     |                                  |                  |
| Time standing over first dist.                  | 6 0 0         |                       |                                |                                  |                  |
| True time at Greenwich                          | 6 44 43       |                       |                                |                                  |                  |
| Time at ship                                    | 6 10 0        |                       |                                |                                  |                  |

Diff. of time between ship and Greenwich  $34 43 = 8^{\circ} 40' 45''$  the longitude in, and it is West, because the time at ship is less than at Greenwich.

## THE METHOD OF FINDING

## EXAMPLE IV.

Suppose a ship at sea in long.  $45^{\circ} 30' W.$  by acc. on June 13, 1796, at 3 H. 17' 20" P. M. the following observations were taken when the eye was 21 feet above the sea, and the corrections of several quadrants as underneath.

| Alt. $\text{D's L. L.}$                                        | Alt. of $\text{D's up. limb.}$ | Dist. of $\text{C \& D, N. L.}$ | Time at ship<br>Long. $45^{\circ} 30' W.$ | H. M. S.                   |
|----------------------------------------------------------------|--------------------------------|---------------------------------|-------------------------------------------|----------------------------|
| D. M. S.                                                       | D. M. S.                       | D. M. S.                        | Red. T.                                   | 3 17 20                    |
| 45 54 0                                                        | 19 32 0                        | 106 16 45                       | $\text{D's Sem. N.}$ 15' 18"              | 3 2 0                      |
| 45 45 0                                                        | 19 52 0                        | 106 17 45                       | Ditto midn. 15 13                         | 6 19 20                    |
| 45 18 45                                                       | 20 5 0                         | 106 18 30                       |                                           | Hor. par. 56 9             |
| 45 4 0                                                         | 20 17 30                       | 106 18 45                       |                                           | Hor. par. 55 49            |
| 44 48 30                                                       | 20 34 0                        | 106 19 15                       | Diff. in 12 hours 5                       | Diff. in 12 H. 20          |
|                                                                |                                |                                 | $\text{D's Sem.}$                         | 15' 18"                    |
| 5) 226 50 15                                                   | 100 20 30                      | 531 31 0                        | Prop. part                                | 3                          |
| Mean 45 22 3                                                   | 20 4 6                         | 106 18 12                       | Augmentation                              | 15 15                      |
| Er. quad. — 48                                                 | — 1 0                          | — 2 37                          |                                           | 6                          |
| 45 21 15                                                       | 20 3 6                         | 106 15 35                       | $\text{D's Sem.}$                         | 15 21                      |
| Dip. — 4 22                                                    | 4 22                           |                                 | $\text{D's obs. alt.}$                    | 19 58 44                   |
| 45 16 53                                                       | 19 58 44                       | 106 15 35                       | $\text{D's app. alt.}$                    | 19 43 25                   |
| Observed dist. of $\text{C}$ and $\text{D}$ 106° 15' 35"       |                                |                                 | $\text{D's hor. par. N. 56' 9"}$          |                            |
| Sum semid. $\text{C}$ and $\text{D}$ 31 8"                     |                                |                                 | Prop. part                                | 11                         |
| App. dist. of their centers 106 46 43                          |                                |                                 | Ditto at red. ti. 55 58                   | Prop. log. 10,5078         |
|                                                                |                                |                                 | $\text{D's ap. alt.}$ 19 43 23            | Co-fine 9,9737             |
|                                                                |                                |                                 | Par. in alt. 52 41                        | P. L. 5335                 |
|                                                                |                                |                                 | Ref. 2 37                                 |                            |
|                                                                |                                |                                 | Cor. $\text{D's alt.}$ 53 4               | Ref. $\text{C's alt. 56"}$ |
|                                                                |                                |                                 | $\text{C's alt.}$ 45 16 53                | Par. 7                     |
|                                                                |                                |                                 | Ditto Sem. 15 47                          | Cor. $\text{C's alt. 49}$  |
|                                                                |                                |                                 | $\text{C's ap. alt. 45 32 40}$            |                            |
| Cor. of $\text{C's alt. 49"}$                                  | P. L. 2,3432                   |                                 |                                           | P. L. 2,3432               |
| $\text{C's App. alt. 45}^{\circ} 32' 40"$                      | Co-fine 9,8454                 |                                 |                                           | Co-t. 9,9917               |
| App. dist. 106 47                                              | Sine 9,9810                    |                                 |                                           | T. 10,5206                 |
| $\text{D's App. alt. 19 43}$                                   | Co-sec. 10,4718                |                                 |                                           |                            |
| Reject 30 P. L. of 1st ang. 25"                                | 2,6414                         |                                 | Reject 20 P. L. 2d ang. 15"               | 2,8555                     |
|                                                                |                                |                                 | App. Dist. 106 46 43                      | 1st ang. 25                |
|                                                                |                                |                                 | Cor. dist. 106 47 23                      |                            |
| Cor. of $\text{D's alt. 50' 4"}$                               | P. L. 0,5557                   |                                 |                                           | P. L. 0,5557               |
| $\text{D's Alt. 19}^{\circ} 43'$                               | Co-fine 9,9737                 |                                 |                                           | Co-t. 10,4456              |
| Cor. dist. 106 47                                              | Sine 9,9810                    |                                 |                                           | T. 10,5206                 |
| $\text{C's app. alt. 45 33}$                                   | Co-sec. 10,1464                |                                 |                                           |                            |
| Pr. log. of 3d ang. 39' 40" reject 30"                         | 0,6569                         |                                 | Rej. 20 P. L. 4th ang. 5' 25"             | 1,5218                     |
|                                                                |                                |                                 | 3d ang. 39 40                             |                            |
|                                                                |                                |                                 | Prin. eff. of par. 45 5                   |                            |
|                                                                |                                |                                 | Cor. dist. 106 47 23                      |                            |
| Diff. corrected for principal effect of ref. and par. 106 2 18 |                                |                                 |                                           |                            |
| First cor. from Table X. 6"                                    |                                |                                 |                                           |                            |
| Second cor. from ditto 4                                       |                                |                                 |                                           |                            |
| Diff. 2                                                        |                                |                                 | Diff. 2                                   |                            |
|                                                                |                                |                                 | True dist. 106 2 16                       |                            |



# THE LONGITUDE AT SEA.

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|                              |             |                                                                                       |             |
|------------------------------|-------------|---------------------------------------------------------------------------------------|-------------|
| 1st dist. at 6 h.            | 105° 58' 3" | True dist.                                                                            | 106° 2' 16" |
| 2d ditto at 9 h.             | 107 24 54   | First dist.                                                                           | 105 58 3    |
| 1st diff.                    | 1 26 51     | P. L.                                                                                 | 4 13        |
| P. L. diff. time             | 8 44        | P. L.                                                                                 | —           |
| T. stand. over the 1st dist. | 6 0 0       |                                                                                       | —           |
| True time at Green.          | 6 8 44      |                                                                                       | —           |
| Time at ship                 | 3 17 20     |                                                                                       | —           |
| Diff. time                   | 2 51 24     | = 42° 51' the long. in, and it is west beause the time at ship is less than at Green. |             |

## EXAMPLE V.

Suppose that on the 15th of May, 1796, in long. 2° E. the eye 21 feet above the sea, the following observations were made, and the true longitude be required?

| Times                                      | Alt. of Spica. | Alt. D's L. L. | Dist. D's far. L. | Time per watch                    | H. M. S. |
|--------------------------------------------|----------------|----------------|-------------------|-----------------------------------|----------|
|                                            |                |                |                   | Long. 2° E.                       | 12 41 19 |
| H. M. S.                                   | D. M. S.       | D. M. S.       | D. M. S.          |                                   |          |
| 12 36 14                                   | 19 50 30       | 18 6 0         | 31 30 45          | Sup. Ti. at Green.                | 12 33 19 |
| 12 39 5                                    | 20 2 0         | 18 21 0        | 31 31 30          | D Semi. 15° 25', and the ang.     |          |
| 12 41 41                                   | 20 15 0        | 18 39 30       | 31 34 0           | 6" added gives the true semi.     |          |
| 12 43 45                                   | 20 29 0        | 18 55 0        | 31 33 0           | 15' 31" and her H. P. is 56' 35". |          |
| 12 45 53                                   | 20 40 0        | 19 9 0         | 31 35 45          | D's obf. alt.                     | 18 45 36 |
| 5) 63 26 38                                | 101 16 30      | 93 10 30       | 157 45 0          | Semi. 15' 31"                     |          |
| Mean 12 41 19                              | 20 15 18       | 18 38 6        | 31 33 0           | Dip 4 22 = diff. 11 9             |          |
| Er. of quadrant.                           |                | + 7 30         | + 24              | App. alt.                         | 18 56 45 |
| 12 41 19                                   | 20 15 18       | 18 45 36       | 31 33 24          |                                   |          |
| Obf. dist.                                 | 31° 33' 24"    | H. P           | 56' 35"           | P. L.                             | 10,5026  |
| D's semi.                                  | 15 31          | Ap. alt.       | 18° 56 45         | L co-fine                         | 9,9758   |
| Ap. dist. of centres                       | 31 17 53       | P. in alt.     | 53 31             | P. L.                             | 0,5268   |
| *'s obf. alt.                              | 20° 15' 18"    | Ref.           | 2 45              |                                   |          |
| Dip                                        | 4 22           | Cor. D's alt.  | 50 46             |                                   |          |
| App. alt.                                  | 20 10 56       |                |                   |                                   |          |
| Cor. of *'s alt.                           | 2' 34"         | P. L.          | 1,8459            | P. L.                             | 1,8459   |
| *'s alt.                                   | 20 11 0        | Co-fine        | 9,9725            | Co-tan.                           | 10,4346  |
| App. dist.                                 | 31 18          | Sine           | 9,7156            | Tan.                              | 9,7839   |
| D's alt.                                   | 18 57          | Co-fec.        | 10,4885           |                                   |          |
| Prop. log. of 1st ang. 1' 43"              |                |                | 2,0225            | P. L. 2d ang. 1' 33"              | 2,0644   |
|                                            |                |                |                   | 1st ang. 1 43                     |          |
|                                            |                |                |                   | Diff.                             | 10       |
|                                            |                |                |                   | Ap. dist.                         | 31 17 53 |
|                                            |                |                |                   | Diff.                             | 31 18 3  |
| Cor. of D's alt.                           | 50' 46"        | P. L.          | 0,5497            | C. for Re.                        |          |
| D's alt.                                   | 18° 57         | Co-fi.         | 9,9758            | P. L.                             | 0,5497   |
| Cor. dist.                                 | 31 18          | Sine           | 9,7156            | Co-tan.                           | 10,4642  |
| *'s alt.                                   | 20 11          | Co-fec.        | 10,4621           | T.                                | 9,7839   |
| Reject 30 P. L. 3d ang. 35' 39"            |                |                | 0,7032            | 4th ang. P. L. 28' 40"            | 0,7978   |
|                                            |                |                |                   | 3d ang.                           | 35 39    |
|                                            |                |                |                   | Prin. eff. of par.                | 6 59     |
|                                            |                |                |                   | Cor. dist.                        | 31 18 3  |
| Diff. cor. for prin. eff. of par. and ref. |                |                |                   |                                   | 31 11 4  |

|                                 |             |             |          |          |
|---------------------------------|-------------|-------------|----------|----------|
| Cor. from table X.              | 37          |             |          | 31 11 4  |
| Cor. from ditto                 | 1 diff.     |             |          | 36       |
| Dist. at 12 hours               | 31° 33' 38" | Comp. dist. | 31 11 40 |          |
| Dist. at 15 hours               | 30 0 21     | Dist. at 12 | 31 33 38 |          |
| 1st diff.                       | 1 33 17     | P. L.       | 2855     | 21 58    |
| 2d diff.                        | 0 21 58     | P. L.       | 9132     |          |
|                                 |             | P. L.       | 6280 =   | H. M. S. |
| Time standing over 1st distance |             |             |          | 0 42 24  |
|                                 |             |             |          | 12       |
| True time at Green.             |             |             |          | 12 42 24 |
| Time at ship                    |             |             |          | 12 41 19 |

Diff. of time between ship and Greenwich 1 5 = 16' 15" the long. in, and it is west, the time at the ship being less than at Greenwich.

## EXAMPLE VI.

Suppose the dist. of the ☉ and ☽'s nearest limbs, with the respective altitudes of their lower limbs, were observed as under on the 13th of April 1796, the eye being 18 feet above the sea, in lat. 34° 17' N. and long. by account 8° 30' W. of Greenwich, the watch not previously regulated, and the ship's true longitude be required?  
As the ☉ must be then at a sufficient distance from the meridian, the mean of the three altitudes may be supposed preferable to any single alt. taken for finding the time.

| Times.       | Dist.  | ☉'s Alt. | ☽'s Alt. | H. M. S.                       | T. at sh.               | ☉'s alt.         | 22 3 0             |
|--------------|--------|----------|----------|--------------------------------|-------------------------|------------------|--------------------|
| H. M. S.     | D. M.  | D. M.    | D. M.    |                                | Lo. in T.               | 34               | fem. 15 58         |
| 4 47 14      | 77 11  | 22 51    | 80 18    | Sup. T.                        | 5 24 57                 | dip 4 3          | Diff. 11 55        |
| 4 50 11      | 77 13  | 22 12    | 80 36    | ☉'s ref.                       | 2° 19' — P. 8' = 2' 11" | cor. of ☉'s alt. | App. alt. 22 14 55 |
| 4 55 26      | 77 18  | 21 6     | 81 9     | ☽'s obs. alt.                  |                         |                  | 80 41 0            |
|              |        |          |          | ☽'s fem. 16' 27" — dip 4' 3" = |                         |                  | 0 12 24            |
| Su. 14 32 51 | 231 42 | 66 9     | 242 3    | ☽'s app. alt.                  |                         |                  | 80 53 24           |
| M. 4 50 57   | 77 14  | 22 3     | 80 41    | ☽'s hor. par.                  | 8' 59' 22"              | P. L.            | 10,4817            |
|              |        |          |          | ☽'s app. alt.                  | 80 53 24                | L. co-f.         | 9,1998             |

Obs. dist. of ☉ and ☽ 77° 14' 0"  
☉'s semi. 15' 58" =  
☽'s ditto 16 27 5 = 0 32 25  
P. L. of ☽'s par. in alt. 9 24 1,2819  
Ref. 9

App. dist. of centres 77 46 25 Cor. of ☽'s alt. 9 15  
Cor. ☉'s alt. 0° 2' 11" P. L. 1,9161 P. L. 1,9161  
☉'s alt. 22 15 0 Co. f. 9,9664 Co-tan. 10,3881  
App. dist. 77 46 0 Si. 9,9900 T. 19,6639  
☽'s alt. 80 53 0 Co. sec. 10,0055

P. L. 2d ang. 12" 2,9681  
Reject 30 first ang. 2 23 P. L. 1,8780 2 23

Diff. 0 2 11  
App. dist. 77 46 25

Diff. cor. for ☉'s ref. 77 48 36  
Cor. ☽'s alt. 0 9' 15" P. L. 1,2891 P. L. 1,2891  
☽'s alt. 80 53 0 Co-f. 9,1998 Co-tan. 9,2054  
Cor. dist. 77 48 36 Sine 9,9201 Tang. 10,6654  
☉'s alt. 22 15 0 Co-sec. 10,4218

4th ang. P. L. 12' 27" = 1,1599  
3d ang. 22 37 P. L. = 0,9008 22 37

Diff. 10 10  
Cor. dist. 17 48 36

Diff. cor. prin. effect of par. and ref. = true dist. 77 38 26 the corrections  
from table X. will give nothing.

| To find the time.     |          |              |                 | By the second method thus: |             |                 |             |
|-----------------------|----------|--------------|-----------------|----------------------------|-------------|-----------------|-------------|
| D. M. S.              |          |              |                 |                            |             |                 |             |
| ☉'s ap. alt.          | 22 14 55 | Dec. 9° 30'  | lat. 34 17      | Co. lat.                   | 55 43       | Co-sec.         | 08288       |
| Cor.                  | 0 2 11   | 90           | 90              | Dec.                       | 9 30        | Sec.            | 00600       |
| True alt.             | 22 12 44 | P. D. 80 30  | C. I. 55 43     | M. alt.                    | 65 13       | N. S. 90790     | L. R. 08888 |
|                       | 90       |              |                 | T. alt.                    | 22 13       | N. S. 37811     |             |
| Z. D.                 | 67 47 16 |              |                 |                            |             | 52979           | Log. 472411 |
| Co. lat.              | 55 43    | 0            | Co-sec. 0,08288 |                            |             |                 |             |
| Pol. dist.            | 80 30    | 0            | Co-sec. 0,00600 | In cel. rising =           | 4h 38' 4"   |                 | 4.81299     |
|                       | 204 0 16 |              |                 | By the Ephemeris,          |             |                 |             |
| $\frac{1}{2}$ sum     | 102 0 8  | Sine         | 9,99040         | Dist. at 3 hours           | 76° 27' 23" |                 |             |
| Z. dist.              | 67 47 16 |              |                 | Dist. at 6 hours           | 78 5 44     |                 |             |
|                       |          |              |                 | True dist.                 | 77 38 26    |                 |             |
| Rem.                  | 34 12 52 | Sine         | 9,74980         | Diff. in 3 hours           | 1 38 21     | P. L. 2625      |             |
|                       |          | Sum          | 19,82908        | Comp. diff.                | 1 11 03     | P. L. 4037      |             |
| $\frac{1}{2}$ H. ang. | 34 46 40 | = Co-f.      | 9,91454         |                            | 2 10 02     | =               | 1412        |
|                       | 2        |              |                 | Time over 1st dist.        | 3 00 00     |                 |             |
| H. ang.               | 69 33 20 | = 4 38 13 Tr |                 | Ti. at Greenwich           | 5 10 02     |                 |             |
|                       |          | H. M. S.     |                 | Tr. time at ship           | 4 38 13     |                 |             |
|                       |          |              |                 | Long. in time              | 31 49       | = 7° 57' 15" W. |             |
|                       |          |              |                 | from Greenwich.            |             |                 |             |

In finding the time the declination is proportioned to the reduced time 6h. 54'.

Here I have given one method of finding the longitude, illustrated by a sufficient number of examples, all of which are reduced to the year 1796, in order that the reader, or teacher, may have sufficient time to furnish himself with a N. A. for that year, which is now printed. But as many would wish to have some other method of reducing the distance, that, by comparing them together, they may not only have the advantage of proving their calculations, but also of making choice of which they prefer to work by.

The second method I shall present the reader with, is chiefly deduced from that invented by Mr. Witchell, late Master of the Royal Academy at Portsmouth, and as it is short, requires but four places of figures in the logarithms, besides the index; the preparations in both methods being exactly the same.

*To find the true Distance, observe this general Rule.*

First. Add the ☉ or \* and ☽'s apparent altitudes together, and take half the sum; subtract the less from the greater, and take half the difference; then add together

The co-tangent of half the sum,

The tangent of half the difference, and

The co-tangent of half the apparent distance,

Their sum, rejecting 20 in the index, will be the log. tangent of an angle, which call A.

I i 2

Secondly.



Secondly. When the ☉ or \*'s altitude is greater than the ☽'s, take the difference between the angle A and half the apparent distance, but if less take their sum. Then add together

The co-tangent of this sum or difference,

The co-tangent of ☉ or \*'s apparent altitude, and

The proportional log. of the correction of the ☉ or \*'s altitude,

Their sum, rejecting 20 in the index, will be the proportional logarithm of the first correction.

Thirdly. If the sum of angle A and half the apparent distance was taken in the last article, take now their difference; but if their difference, take now their sum. Then add together

The co-tangent of this sum or difference,

The co-tangent of ☽'s apparent altitude, and

The proportional log. of the correction of the ☽'s apparent altitude.

Their sum, rejecting 20 in the index, will be the proportional log. of the second correction.

Fourthly. When the angle A is less than half the apparent distance, the first correction must be added to, and the second subtracted from the apparent distance; but, when the angle A is greatest, their sum must be added to the apparent distance, when the ☉ or \*'s altitude is less than the ☽'s; but when the ☽'s altitude is least, their sum must be subtracted to give the corrected distance.

Fifthly. In table X. look for the corrected dist. in the top column, and the correction of ☽'s alt. in the left-hand side column; take out the number of seconds that stand under the former and opposite to the latter. Look again in the same table for corrected distance in the top column, and the second correction in the left-hand side column; take out the number of seconds that stand under the former and opposite the latter, the difference between these two numbers will be the third correction, which must be added to the corrected distance, if less than  $90^\circ$ , but subtracted from it, if more than  $90^\circ$ ; the sum, or difference, will be the true distance.

To illustrate this last method of reducing the apparent distance to the true distance, I shall take the apparent altitudes and distances as they stand in the three first examples, worked by the former method.

#### EXAMPLE I. See page 243.

Given the apparent distance of the ☽'s centre from the \*  $63^\circ 35' 13''$ , the ☽'s apparent altitude  $24^\circ 29' 44''$ , and that of the \* Regulus  $45^\circ 9' 12''$ , the ☽'s horizontal parallax  $55' 2''$ . Required the true distance?

|                          | D.  | M.      | S. |                  |         |           |         |
|--------------------------|-----|---------|----|------------------|---------|-----------|---------|
| *'s altitude             | 45  | 19      | 12 | ☽'s Hor. par.    | 55' 2'' | P. L.     | 10,5146 |
| Ref. or cor. of *'s alt. |     | 57      |    | App. alt.        | 24° 30' | Log. cos. | 9,9590  |
|                          |     |         |    | ☽'s Par. in alt. | 50' 5'' |           | 0,5556  |
|                          |     |         |    | Ref.             | 2 4     |           |         |
| *'s app. alt.            | 45° | 9' 12'' |    | Cor. of ☽'s alt. | 48 1    |           |         |
| ☽'s app. alt.            | 24  | 29 44   |    |                  |         |           |         |
| Sum                      | 69  | 38 56   |    |                  |         |           |         |

Half

# THE LONGITUDE AT SEA.

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|                                                       |                   |                     |             |         |         |
|-------------------------------------------------------|-------------------|---------------------|-------------|---------|---------|
| Sum                                                   | 69° 38' 56"       | Half is             | 34° 49' 28" | Co-tan. | 10,1577 |
| Difference                                            | 20 39 28          | Half is             | 10 19 44    | Tang.   | 9,2601  |
| App. dist.                                            | 63 35 13          | Half is             | 31 47 36    | Co-tan. | 10,2078 |
| 1st Cor. add                                          | 9                 | Ang. A.             | 22 54 0     | Tang.   | 9,6256  |
| 2d Cor. sub.                                          | 63 35 22<br>30 54 | Diff.               | 8 53 36     | Co-tan. | 10,8056 |
| Corrected dist.                                       | 63 4 28           | *'s Alt.            | 45 9 12     | Co-tan. | 9,9977  |
| 3d Correction add                                     | 5                 | *'s Cor.            | 57          | P. L.   | 2,2775  |
| True distance                                         | 63 4 33           | 1st Cor.            | 9           | P. L.   | 3,0808  |
| Differing 2" from that found<br>by the former method. |                   | Half app. dist.     | 31 47 36    |         |         |
|                                                       |                   | Angle A.            | 22 54 0     |         |         |
|                                                       |                   | Sum                 | 54 41 36    | Co-tan. | 9,8501  |
|                                                       |                   | ☉'s Alt.            | 24 29 44    | Co-tan. | 10,3413 |
|                                                       |                   | Cor. ☉'s alt.       | 48 1        | P. L.   | 0,5739  |
|                                                       |                   | 2d Cor.             | 30 54       | P. L.   | 0,7653  |
|                                                       |                   | 1st Cor. tab. X.    | 9           |         |         |
|                                                       |                   | 2d Cor. ditto       | 4           |         |         |
|                                                       |                   | 3d Cor. of distance | 5           |         |         |

## EXAMPLE II. See page 244.

Given the apparent altitude of the ☉'s centre 32°, that of the ☽'s 24°, and the apparent distance of their centres 68° 42' 11", and the ☽'s horizontal parallax 58' 10"

Required the true distance?

|                  |        |               |         |         |         |
|------------------|--------|---------------|---------|---------|---------|
| Ref. of ☉'s alt. | 1' 31" | ☽'s Hor. par. | 58' 10" | P. L.   | 10,4906 |
| Par. in alt.     | 8      | ☽'s Alt.      | 24° 0 0 | Co-fine | 9,9607  |
| Cor. of ☉'s alt. | 1 23   | Par. in alt.  | 53 8    | P. L.   | 0,5299  |
|                  |        | Ref.          | 2 7     |         |         |
|                  |        | Cor. ☽'s alt. | 51 1    |         |         |

|                                                       |            |               |         |         |         |
|-------------------------------------------------------|------------|---------------|---------|---------|---------|
| ☉'s Alt.                                              | 32°        |               |         |         |         |
| ☽'s Alt.                                              | 24         |               |         |         |         |
| Sum                                                   | 56         | Half is       | 28      | Co-tan. | 10,2743 |
| Difference                                            | 8          | Half is       | 4       | Tang.   | 8,8446  |
| App. Dist.                                            | 68 42 11   | Half is       | 34 21 5 | Co-tan. | 10,1653 |
| 1st Cor. add                                          | 23         | Ang. A.       | 10 54   | Tang.   | 9,2842  |
| Cor. dist.                                            | 68 42 34   | Diff.         | 23 27 5 | Co-tan. | 10,3627 |
| 2d Cor. sub.                                          | 22 55      | ☉'s Alt.      | 32      | Co-tan. | 10,2042 |
| 1st Cor. tab. X.                                      | 8 68 19 39 | Cor. ☉'s alt. | 1' 23"  | P. L.   | 2,1143  |
| 2d Cor. ditto                                         | 1 Diff. 7  | 1st Cor.      | 23      | P. L.   | 2,6812  |
| True dist.                                            | 68 19 46   | Half dist.    | 34 21   |         |         |
|                                                       |            | Ang. A.       | 10 54   |         |         |
| Differing 2" from that found<br>by the former method. |            | Sum           | 45 15   | Co-tan. | 9,9962  |
|                                                       |            | ☽'s Alt.      | 24 0    | Co-tan. | 10,3514 |
|                                                       |            | Cor. ☽'s alt. | 51' 1"  | P. L.   | 0,5475  |
|                                                       |            | 2d Correction | 22 55   | P. L.   | 0,8951  |

EXAMPLE

## EXAMPLE III. See page 245.

Given the ☉'s apparent altitude  $18^{\circ} 59' \frac{1}{2}$ , the ♃'s  $70^{\circ} 44'$ , the apparent distance of their centres  $103^{\circ} 30' 8''$ , and the ♃'s horizontal parallax  $59' 15''$ . Required the true distance?

|                                                   |           |                                     |          |         |         |
|---------------------------------------------------|-----------|-------------------------------------|----------|---------|---------|
| Refrac. of ☉'s alt.                               | 2' 44"    | ♃'s Hor. par.                       | 59' 15"  | P. L.   | 10,4826 |
| Par. in alt.                                      | 8         | ♃'s alt.                            | 70° 44   | Co-sine | 9,5185  |
| Cor. of ☉'s alt.                                  | 2 36      | Par. in alt.                        | 19 33    | P. L.   | 0,9641  |
| ☉'s App. alt.                                     | 18° 59 30 | Ref.                                | 19       |         |         |
| ♃'s Ditto                                         | 70 44 0   | Cor. ♃'s alt.                       | 19 14    |         |         |
| Sum                                               | 89 43 30  | Half is                             | 44 51 45 | Co-tan. | 10,0020 |
| Diff.                                             | 51 44 30  | Half is                             | 25 52 15 | Tang.   | 9,6857  |
| App. dist.                                        | 103 30 8  | Half is                             | 51 45 4  | Co-tan. | 9,8967  |
|                                                   |           | Angle A.                            | 21 1     | Tang.   | 9,5844  |
| 1st Cor. add                                      | 2 53      | Sum, ang. A, and $\frac{1}{2}$ dif. | 72 46 4  | Co-tan. | 9,4916  |
|                                                   | 103 33 1  | ☉'s app. alt.                       | 18 59 30 | Co-tan. | 10,4632 |
| 2d Cor. sub.                                      | 32 43     | Cor. ☉'s alt.                       | 2 36     | P. L.   | 1,8403  |
| Cor. diff.                                        | 103 0 18  | 1st Cor.                            | 2 53     | P. L.   | 1,7951  |
| 1st Cor. tab. X.                                  | 0         | Angle A                             | 21 1     |         |         |
| 2d Cor. ditto                                     | 2 diff. 2 | $\frac{1}{2}$ App. dist.            | 51 45 4  |         |         |
| True dist.                                        | 103 0 16  | Diff.                               | 30 44 4  | Co-tan. | 10,2258 |
| Differing 3" from that found by the first method. |           | ♃'s alt.                            | 70 44 0  | Co-tan. | 9,5435  |
|                                                   |           | Cor. ♃'s alt.                       | 19 14    | P. L.   | 0,9712  |
|                                                   |           | 2d Cor.                             | 32 43    | P. L.   | 7405    |

I shall leave the working of the other examples by this method, to exercise the learner, and proceed to shew how to find the true altitudes of the ☉, ♃, or a \* by calculation.

*To find the Sun's true Altitude.*

It sometimes happens, that the distance of the celestial objects may be taken, but for want of a good horizon, or assistants, their altitudes cannot be taken at the same time; to supply such deficiencies, observe the three following cases.

## CASE I.

The apparent time, the ship's latitude, longitude, and the ☉'s declination given, to find the true altitude of his centre.

## RULE.

If the ship's co. latitude and the ☉'s declination be both north or both south, their sum; but if one be north and the other south, their difference is the ☉'s meridian altitude.

With the apparent time from noon, enter table VI. and from the column of rising take out the logarithm corresponding to it.

To this logarithm, add the log. co-sine of the latitude, and the log. co-sine of the ☉'s declination.

Their



Their sum, rejecting 20 in the index, will be the logarithm of a natural number, which being subtracted from the natural sine of the ☉'s meridian altitude, will leave the natural sine of his true altitude at the given time.

## EXAMPLE I.

Required the true altitude of the ☉'s centre, in lat.  $49^{\circ} 57' N$ . July 25, 1796, at 6 H. 56 M. 30 S. in the morning?

|                    |                   |                                |                            |
|--------------------|-------------------|--------------------------------|----------------------------|
| App. time          | 12 0 0<br>6 56 30 |                                |                            |
| Time from noon     | 5 3 30            | Its log. in col. of rising     | 4.87850                    |
| Latitude           | 49 57 0           | N. its log. co-fine            | 9.80852                    |
| Decl. at that time | 19 26 0           | N. its log. co-fine            | 9.97452                    |
| Co. lat.           | 40 3              | Reject 20 N. N. 45871 = log. = | 4.66154                    |
| Mer. alt.          | 59 29             | Nat. fine                      | 86148                      |
|                    |                   | Nat. fine true alt.            | 40277 = $23^{\circ} 45'$ . |

## EXAMPLE II.

What will be the true altitude of the ☉'s centre at London, November 24, 1796, at 3 H. 21 M. 30 S. apparent time in the afternoon?

|                     |                     |                            |         |
|---------------------|---------------------|----------------------------|---------|
| App. time from N.   | H. M. S.<br>3 21 30 | Its log. in col. of rising | 4.55900 |
| Latitude            | 51° 32' N.          | Log. cofine                | 9.79383 |
| Decl. at that time  | 20 49 S.            | Log. co-fine               | 9.97068 |
| Co. lat.            | 38. 28 N.           | Nat. num. 21062 = log. =   | 4.32351 |
| Mer. alt.           | 17 39               | Nat. fine                  | 30320   |
| Nat. fine true alt. | 5 19                | Nat. fine                  | 09258   |

## CASE II.

*The apparent Time, the Latitude and Longitude given, to find the Altitude of any of the known fixed Stars.*

## R U L E.

Turn the longitude into time, and add it to or subtract it from the time at the ship, according as it is east or west, the sum or difference will be the time at Greenwich.

Take the ☉'s Rt. Ascen. from the N. A. and proportion it to the time at Greenwich, and add it to the apparent time at the ship, which will give the Rt. Ascen. of the meridian, or mid-heaven.

Find the \*'s Rt. Ascen. and declination in table XX. and take the difference between its Rt. Ascen. and the Rt. Ascen. of the meridian, which will be the distance of the \* from the meridian.

Having

Having the  $\star$ 's distance from the meridian, with its declination and the ship's latitude, the true altitude is found in the same manner as has been shewn in the last examples of finding the true Altitude of the sun.

## E X A M P L E.

What will be the true altitude of Aldebaran at Edinburgh, April 11, 1796, at 5 H. 56 M. 20 S. apparent time.

|                                 | H. M. S.            |                             | H. M. S. |
|---------------------------------|---------------------|-----------------------------|----------|
| App. time                       | 5 56 20             | $\odot$ 's Rt. Ascen. at N. | 1 23 27  |
| Long. $3^{\circ} 6' W.$ in time | 12 24               | Prop. part for 6 hours      | 55       |
| App. time at Green.             | 6 8 44              | Rt. Ascen. at Edinburgh     | 1 23 22  |
| Rt. Ascen. at Edin.             | 1 23 22             |                             |          |
| Rt. Ascen. Merid.               | 7 32 6              |                             |          |
| $\star$ 's Rt. Ascen.           | 4 24 14             |                             |          |
| $\star$ 's dist. from merid.    | 3 7 52              | Its log in col. of rising,  | 4,50184  |
| Edinburgh's lat.                | $55^{\circ} 58' N.$ | Log. co-sine                | 9,74794  |
| $\star$ 's decl.                | 16 5 19 N.          | Log. co-sine                | 9,98266  |
| Co. lat.                        | 34 2 N.             | Nat. num. 17078 log.        | 4,23244  |
| Meridian altitude               | 50 7 19             | Nat. sine                   | 76735    |
| True altitude                   | 36 37               | Nat. sine                   | 59657    |

NOTE. As the table is calculated only to  $30''$ , the difference between the log. of 3 H. 7 M. 30 S. and 3 H. 8 M. must be taken, which is 218: Then say, as 30 : 218 :: 22 : 159, which being added to 4,50025 the log of 3 H. 7 M. 30 S. gives 4,50184, the log of 3 H. 7 M. 52 S. as above.

## C A S E III.

*The apparent Time, the Latitude and Longitude of the Ship given, to find the true Altitude of the Moon's Centre.*

## R U L E.

Turn the longitude into time, and if it be west add it to, but if it be east subtract it from the apparent time at the ship, and it will give the time at Greenwich.

Take the  $\odot$ 's Rt. Ascen. out of the N. A. and proportion it to Greenwich time, which being added to the time at the ship, the sum will be the Rt. Ascen. of the meridian or mid-heaven.

Take out of the N. A. the  $\delta$ 's Rt. Ascen. and declination, and proportion them to the time at Greenwich. Turn the  $\delta$ 's Rt. Ascen. into time, and take the difference between it and the Rt. Ascen. of the mid-heaven, which will be the distance in time of the  $\delta$  from the meridian.

Having the ship's latitude, together with the  $\delta$ 's declination and distance from the meridian, the true altitude is found, in the same manner as has been shewn in finding the true altitude of the  $\odot$  and  $\star$ .

E X A M-

## EXAMPLE.

What will be the  $\text{D}$ 's true altitude at 19 H. 16 M. 52 S. apparent time, in latitude  $14^{\circ} 45' \text{S}$ . and longitude  $167^{\circ} \text{E}$ . on August 24, 1796?

App. time at ship 19 16 52

Long.  $167^{\circ} \text{E}$ . in time 11 8 0

App. time at Greenwich 8 8 52

$\odot$ 's Right ascension 10 16 58

$\text{D}$ 's ditto

$47^{\circ} 14'$

App. time at ship 19 16 52

29 33 50

24

Right ascension of the merid. 5 33 50

$\text{D}$ 's Right ascen. in time 3 8 56

$\text{D}$ 's dist. from the merid. 2 24 54

Log. rising

4,28623

Latitude  $14^{\circ} 45'$

Log. co-sine

9,98545

$\text{D}$ 's decl. at ship  $13^{\circ} 30' \text{N}$ .

Log. co-sine

9,98783

Co. Latitude 75 15 S. Nat. num. 18182 Log.

4,25951

Meridian altitude 61 45 Nat. fine 88089

N. fine of  $\text{D}$ 's true alt.  $44^{\circ} 21' = \text{N. fine}$  69907

In the last example proportional parts are taken in finding the right ascension, declination and log. rising.

By the three last cases the true altitudes of the objects are found, therefore if the apparent altitudes be wanted, the difference between the  $\odot$ 's parallax and refraction must be added to the  $\odot$ 's true altitude, the refraction must be added to the true altitude of a star, and the difference between the  $\text{D}$ 's refraction and parallax in altitude must be subtracted from the true altitude of the  $\text{D}$  thus found, to obtain the respective apparent altitudes of their centres.

*To find the Longitude by the Eclipses of Jupiter's Satellites.*

On the day preceding the evening on which it is proposed to observe an eclipse, look for the time when it will happen at Greenwich, in page 3d of the month in the Ephemeris. Find the diff. of longitude, either by a good map, sea chart, or dead reckoning.

Let the watch be regulated by the  $\odot$  with all possible exactness to the apparent time. Turn the difference of longitude into time, and add it to or subtract it from the apparent time, according as it is east or west of Greenwich, the sum or difference will be nearly the time when the eclipse is to be looked for in that place. But as the longitude is uncertain, it will be proper to begin 20 or 30 minutes before.

Observe the hours, minutes and seconds of the beginning of the eclipse, called immersion, that is, the very instant that the satellite appears to enter

K k

ter



ter into the shadow of Jupiter; or the immersion, that is, when it appears to come out of the same. The difference of time between the observed immersion, or emerfion, and that set down in the N. A. being turned into degrees, will give the difference of longitude between Greenwich and the place of observation.

These observations made on the first satelite, or that which moves nearest to the body of Jupiter, is the most proper for determining the longitude; and here it may be observed, that its emerfions are not visible from the time of Jupiter's conjunction with the ☉ to the time of his opposition to the ☉, and that its immersions are not visible from the time of planet's opposition to the ☉, to the time of its conjunction.

The configurations, or the positions in which Jupiter's satellites appear at Greenwich, are laid down every night when visible, in the page the 12th of the month in the Ephemeris.

### EXAMPLE.

Suppose that on the 17th of August, 1796, in long.  $88^{\circ} 30'$  west by account, an immersion of Jupiter's first satelite was observed at 12 H. 30 M. 20 S. apparent time. Required the longitude?

|                                                           |          |
|-----------------------------------------------------------|----------|
|                                                           | H. M. S. |
| At Greenwich, the immer. of 1st satelite that day will be | 18 20 30 |
| Observed immersion at                                     | 12 30 20 |

|                                                                                                                                                                                                |         |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| Difference in time                                                                                                                                                                             | 5 50 10 |
| Turned into longitude gives $87^{\circ} 34' \frac{1}{2}$ , and is west, because the time at Greenwich is more than at the place of observation; the error in longitude $58 \frac{1}{2}$ miles. |         |

As these eclipses happen almost daily, they afford the most ready means of determining the longitude of places on land, and then the longitudes of sea coasts might be better ascertained than they are at present; they might also be applied at sea, could they be observed with sufficient accuracy in a ship under sail, which can hardly be done, since the least motion of a telescope that magnifies sufficiently to make these observations, would throw the objects out of the field of view.

The eclipses of Jupiter's satellites may be well observed by one of Dolland's new achromatic telescopes of three feet in length, or by a reflecting telescope of 18 or 20 inches focal length.

### *To find the Longitude by the Eclipses of the Moon.*

This is performed by comparing the times of the beginning or ending, as also the times when any number of digits are eclipsed, or when the earth's shadow begins to touch or leave any remarkable spot on the moon's face.

Then will the difference of time between the like observations made at different places, turned into degrees, be their difference of longitude.

But these eclipses happen too seldom to be of any general use at sea.

OBLIQUE

## OBLIQUE TRIGONOMETRY.

## AXIOM II.

IN all plane triangles the sides are in direct proportion to the sines of their opposite angles.

To find a Side.

As the sine of an angle

Is to its opposite side,

So is the sine of either of the other angles in the same triangle,

To the side opposite thereto.

To find an Angle.

As any side given

Is to the sine of its opposite angle,

So is either of the other sides in the same triangle,

To the sine of its opposite angle.

## CASE I.

Two angles and one side given, to find either of the legs?

The angle  $BDC = 100^\circ$

and angle  $DCB = 54^\circ$

And the leg  $BD = 220$  are given to find the sides.



## CONSTRUCTION.

Draw an indefinite line GE, add the two angles D and C together, and subtracting their sum from  $180^\circ$  leaves the remaining angle B  $26^\circ$  on the line GE; on any point, as at B, describe the angle B  $26^\circ$ , and on BH set off BD 220. On D make the angle BDC  $100^\circ$ , then DC will intersect the line GE in the point C, which completes the triangle, and BC will measure on the same scale from which BD was laid down 268 nearly, and DC 119 also on the same scale.

To find CB.

As the sine of the angle C  $54^\circ$

Is to the side BD 220

So is supt. fi. of ang. BCD  $80^\circ$

12.33577

9.90796

To the side BC 267.8

2.42781

To find DC.

As sine ang. C.  $54^\circ$

Is to side BD 220

So sine ang. B  $26^\circ$

9.90796

2.34242

9.64184

11.98426

9.90796

To side DC

119.2

2.07630

By the Gunter.

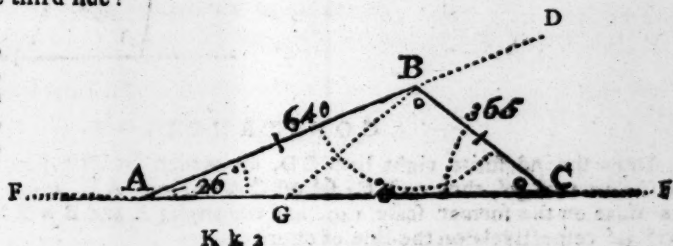
1st. The extent from  $80^\circ$  to  $54^\circ$  on the line of sines will reach from 220 to 267. on the line of numbers for BC.

2d. The extent from  $54^\circ$  to  $26^\circ$ , on the line of sines will reach from 220 to 119. On the line of numbers for the side DC.

## CASE II. and III.

Two sides and an angle opposite to one of them being given, to find the other opposite angles and the third side?

The side BC 365,  
and the side AB 640,  
and angle A  $26^\circ$  given  
to find the side AC,  
and angles ABC,  
and BCA.



## CONSTRUCTION.

Draw the indefinite line FE, and on any point therein, as at A, draw the angle DAE  $26^\circ$ . On AD set off AB = 640, then on B, with 365 in your compasses, taken from the same scale, describe an arch which will cut FE in the point C. Join BC, and it is done. AC will measure on the scale before used 809 nearly, the angle B will measure on the scale of chords  $103\frac{1}{2}$ , and angle C  $50\frac{1}{2}$  nearly.

Proportion by Axiom II.

To find the angle C.

As the side BC 365  
Is to the sine of angle A  $26^\circ$   
So is the side AB 640

2,56229  
9,64184  
2,80618

12,44802  
2,56229

To sine angle C  $50^\circ 14'$   
Angle A add 26 0

Subtract 76 14  
from 180

Angle B 103 46

To find AC.

As sine ang. C  $50^\circ 14'$   
Is to AB 640  
So is si. ang. B, or its suppl.  $76^\circ 14'$

9,88573  
2,80618  
9,98734

To side AC 808,7

12,79352  
9,88573

2,90779

It may be proper to observe, that if the given angle be obtuse, the angle sought will be acute; but when the given angle is acute, and opposite a given lesser side, then the required angle is doubtful whether acute or obtuse, it ought therefore to be determined before the operation; for it is plain the above proportion produces  $59^\circ 17'$  for the required angle, but as it is obtuse, its supplement to  $180^\circ$  must be taken, viz.  $120^\circ 43'$ .

By the Gunter.

1st. The extent from 365 to 640 on the line of numbers will reach from  $26^\circ$  to  $50^\circ 14'$ . On the line of sines equal the angle B.

2d. The extent from  $50^\circ 14'$  to  $76^\circ 14'$  on the sines will reach from 640 to 809 on the line of numbers equal AC.

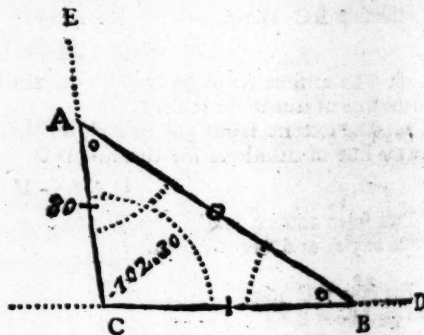
## AXIOM III.

In every plane triangle it will be as the sum of any two sides is to their difference, so is the tangent of half the sum of the angles opposite these sides, to the tangent of half their difference; which half difference being added to half the sum of the angles gives the greater angle, but being subtracted the remainder will be the lesser angles.

## CASE IV, and V.

Two sides and their contained angle being given, to find either of the other angles, and the third side?

The side BC 110° AC 80° and angle BAC  $102^\circ 30'$ , to find the angle BAC and CBA.



## CONSTRUCTION.

Draw the indefinite right line CD, on which set off CB = 110, make the angle ECB =  $102^\circ 30'$ , then on EC; set off CA 80, join AB, and it is done for AB will measure on the former scale 149, and the angles A and B will measure  $45^\circ 58'$ , and  $31^\circ 32'$  respectively on the line of chords.



The proportion by axiom III. will be,

To find the angles B and A.

|                                   |                  |          |
|-----------------------------------|------------------|----------|
| As the sum of the sides AC and BC | 190              | 2.27875  |
| Is to their difference,           | 30               | 1.47712  |
| So is tan. half sum oppo. angles  | $38^{\circ} 45'$ | 9.90449  |
|                                   |                  | 11.38161 |
|                                   |                  | 2.27875  |

To tang. half diff.

$$7^{\circ} 13' = 9.10286$$

By Gunter.

1st. The extent from 190 to 30, on the line of numbers, will reach from  $38^{\circ} 45'$  to  $7^{\circ} 13'$ , on the line of tangents for half difference.

2d. The extent from  $77^{\circ} 30'$ , which is the supplement of  $102^{\circ} 30'$  to  $180^{\circ}$  to  $31^{\circ} 32'$ , on the line of sines will reach from  $80^{\circ}$  to  $149^{\circ} 3'$ , on the line of numbers for the side AB required.

The learner may be at a loss how to know to which angles the above sum and difference belong, but let him remember the biggest angle is opposite the biggest side, and the contrary, which will determine it.

#### AXIOM IV.

In any plane triangle, it will be

As the greatest side

Is to the sum of the other two sides,

So is the difference of those sides

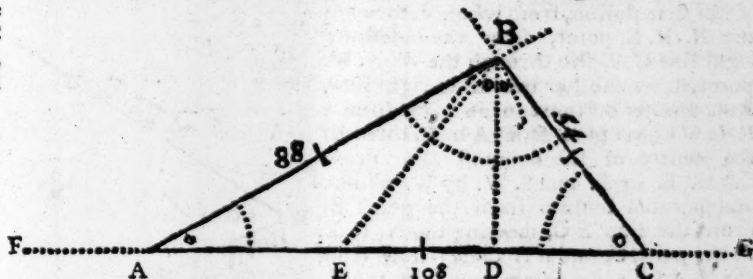
To the difference of the segments of the base made by a perpendicular, let fall from the angle opposite the base.

And half the difference of the segments added to half their sum will give the greater segment, but if subtracted from their half sum will leave the lesser segment, the triangle being thus cut, becomes 2 right-angled triangles, the hypotenuses and bases of which are given, to find the angles by axiom I.

#### CASE VI.

The three sides of a plane triangle given to find the angles?

The side  
BA 88, BC  
54, AC 108,  
given, to find  
the angles  
ABC, BAC,  
BCA.



#### CONSTRUCTION.

Draw the indefinite right line FG, on which from any point therein, as at A, set off AC 108, then 88 in your compasses, and one foot on the point A, sweep an arch also with the distance 54 in your compasses, and one point on C, sweep another arch intersecting the former arch in the point B, and it is done; BA, BC, AC, will measure 88 54 108 respectively on the same scale.

The proportion by axiom IV.

To find  $AE = AD - DC$  the diff. of segments.

|                  |                       |                                   |         |
|------------------|-----------------------|-----------------------------------|---------|
| 88               |                       |                                   |         |
| 54               |                       |                                   |         |
| 142              | Sum of shortest sides | As the side AC                    | 108     |
| 34               | Diff. ditto           | Is to the sum of sides AB and BC  | 142     |
|                  |                       | So is diff. sides AB and BC       | 34      |
|                  |                       |                                   | 1.53148 |
| Half base        | 54                    |                                   | 3.68377 |
| Half diff. segm. | 22 35                 |                                   | 2.03342 |
| AD               | 76 35                 | Great segment                     |         |
| DC               | 31 65                 | Least segmt.                      |         |
|                  |                       | To AE the diff. of segmt. of base | 44 7    |
|                  |                       | Half                              | 22 35   |
|                  |                       |                                   | 1.65035 |

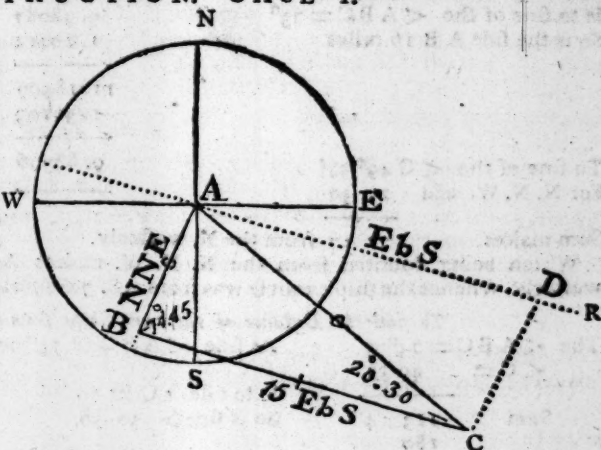


## EXAMPLE II.

Being at sea, I saw two head-lands, whose bearing from one another I find by the chart, to be W. by N. and E. by S. distance 15 miles, the northernmost bore from me S. E. by E. and the southernmost S. S. W. I demand my distance to each of the said head-lands?

## CONSTRUCTION. CASE I.

Having drawn the compass, set off the bearings as AB the S. S. W. bearing, and AC the S. E. by E. course, draw through the centre the dotted line representing the bearings of the two places from one another; and from A towards R, on this line, set off from any scale of equal parts, 15 miles, from A to B, and draw B, draw DC parallel to BA until it cuts AC at the point C, through C draw BC parallel to AD and it is done.



## Calculation of the Angles.

Between N. N. E. and E. by S. is 7 points, or  $78^{\circ} 45'$  =  $\angle ABC$ , between S. S. W. and S. E. by E. is 7 points, or  $78^{\circ} 45'$  = the  $\angle BAC$ , consequently, the  $\angle ABC$ , and  $BAC = 14$  points taken together, wherefore, taking 14 from 16 the numbers of points in a triangle remains 2 points, or  $22^{\circ} 30'$  for the remaining  $\angle BAC$ .

## Calculation of the Sides.

As sine  $78^{\circ} 45' =$   
Is to  $BC = 15$  miles  
So is sine  $22^{\circ} 30' = \angle C$

$$\begin{array}{r} 9.99157 \\ 1.17609 \\ \hline 9.58284 \\ 10.75893 \\ \hline 9.99157 \\ 0.76736 \end{array}$$

It being an isosceles triangle.  
 $AC = BC = 15$  miles.

So  $AB = 5853$  miles

This example and the first, are used for finding the distance of a ship from any head-land, &c. when the ship is about to take her departure from the land.

## CASE II.

The bearings and distance of two places from each other, and the distance of one of those places and the bearing of the other, from a third place being given, to find the bearing of the first, and the distance of the second from the third place.

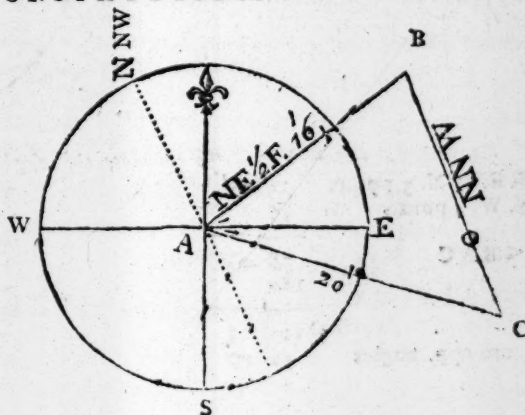
## EXAMPLE I.

Admit two ships sail from the said road, one sails N. E.  $\frac{1}{2}$  E. easterly 16 miles, the other sails 20 miles, and then finds the first to bear N. N. W. I demand the distance between the two ships?

## CONSTRUCTION.

1st. Having drawn the compass, let A be the place the ships departed from, and draw the N. E.  $\frac{1}{2}$  E. line AB equal 16 miles.

2d. From B draw the right line BC parallel to N. N. W. then with 20 miles between the compasses, setting one foot in A, with the other cross the line BC as in C, and join AC, then is the  $\angle BAC$  the course which the second ship steered, reckoned from the N. E.  $\frac{1}{2}$  E. southerly, to find which,





*Calculation of the Angles.*

From B C bears S. S. E. the opposite point to N. N. W. which is a point, also A bears from the same point B, S. W.  $\frac{1}{2}$  W. the opposite point to N. E.  $\frac{1}{2}$  E. which  $\frac{1}{2}$  points from the S. W. by W. and two from the S. easterly, make  $6\frac{1}{2}$  points for the  $\angle A B C$ , from whence you find the  $\angle C$  thus:

As the side A C = 20 miles

1. 30103

Is to sine of the  $\angle A B C = 73^\circ$

9. 98087

So is the side A B 16 miles

1. 20412

11. 18499

1. 30103

To sine of the  $\angle C 49^\circ 57'$

9. 88396

For N. N. W. add 22 30

Sum makes 72 27 from the N. westerly.

Which being counted from the N. N. W. makes A C to bear from N.  $72^\circ 27'$  westerly, whence the ship's course was from A S.  $72^\circ 27'$  easterly, or E. S. E.  $\frac{1}{2}$  E. nearly.

*To find the Distance of the two Ships from one another.*

The  $\angle A B C = 73^\circ 07'$

As sine  $\angle A B C = 73^\circ 07'$

9. 98087

$\angle C = 49 57$

Is to side A C = 20

1. 30103

Sum 123. 4

So is sine  $\angle C 56 56$

9. 92326

180

11. 22429

$\angle A 56 56$

9. 98087

To side B C =  $17^\circ 32$  miles

175 1

1. 24342

### CASE III.

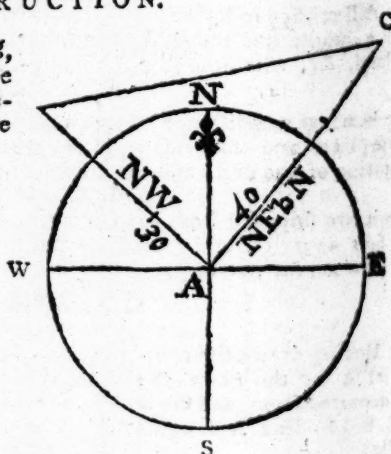
The bearings and distances of any two places from a third being given, to find the bearings of the said places, and their distance from each other.

### EXAMPLE I.

Admit two ships set sail from the same port, one whereof sails N. W. 30 miles, the other sails N. E. by N. 40 miles. I demand their bearings and distance from each other?

### CONSTRUCTION.

From A set off the N. W. course A B, which make 30 miles, also draw the second ship's course A C, and set off thereon 40 miles, from the same scale before used, join B C, and it is done.



*To calculate the Angles.*

N. E. by N. 3 points  $33^\circ 45'$

N. W. 4 points  $45$

$\angle B A C$

78 45

180

H. um opp. angles

2) 101 15

50 37

As sum of sides A B and A C = 70  
Is to their difference 10  
So is tang.  $\frac{1}{2}$  sum opp.  $\angle$ s 50 37 <

1,84510  
1,00000  
10,08570  
11,08570  
1,84510

To find the distance from each other.

As the ft. ang. B  $60^{\circ} 30'$  9,93970  
Is to side A C  $40'$  1,60206  
So is sine ang. A  $78^{\circ} 45'$  9,99157  
11,59363  
9,93970

To tang.  $\frac{1}{2}$  diff. 9 52  $\frac{1}{2}$

Angle B Sum 60 30  
Angle C Diff. 40 45  
Angle A 78 45

Sum 180 0

Angle C 40 45  
N.E. by N. 33 45

Sum 74 30 the bearing from C,  
or W. by S.  $\frac{1}{2}$  S. nearly.

9,24060 To their dist. BC = 45.8 1,65393

## CASE IV.

The mutual distances of three places from each other, and also the bearing of any two of them being given, to find the several bearings of these two from the third place.

## EXAMPLE.

Admit there be two ports lying E. by N. and W. by S. distance 400 miles, a ship from the eastermost sails northerly 450,7 miles, another from the westernmost sails 300 miles and meets the first, I demand the course steered by each ship.

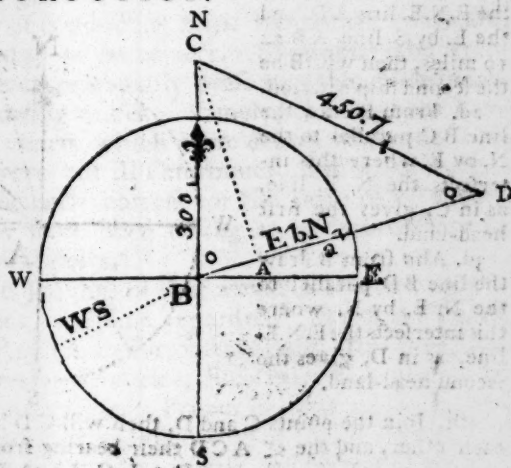
## CONSTRUCTION.

1st. Having drawn the compass N.E.S.W. let B, the center, represent the westernmost port, and draw the E. by N. line B D, on which set off 400 miles to D, then will D be the eastermost port.

2d. With 300 between your compasses, and one foot on B, describe an arch.

3d. With 450 in your compasses, and one foot on D, describe another arch intersecting the former arch, as at C, join C B and C D.

4th. Making B D the base from C, let fall the perpendicular C A thereon, which will divide the oblique-angled triangle B C D into two right-angled triangles B C A, and A C D.



By Axiom IV.

As the base B D 400

2,60206

To find the Course from D, in  $\angle$  A C D.

As the hypoth.

450,7

2,65389

Is to sum of sides B C & C D 750,7

2,87547

Is to radius

90

10,00000

So is diff. of sides B C & C D 150,7

2,17811

So is A D

341,4

2,53326

5,05358

2,60206

12,53326

2,65389

To diff. segts. of base 282 8

2,45152

To co-sine ang. D 40. 46

9,87937

Half which

141 4

Subtract E. by N. 11. 15

Add to  $\frac{1}{2}$  base

200 0

Remains W. 29. 31 N. for the ship's course from D, the eastermost port.

Sum is gr. segt. A D = 341 4

Diff = the less. segt. A B 58 6

*To find the Course from B, in  $\triangle B C A$ .*

|                |                  |                                                          |
|----------------|------------------|----------------------------------------------------------|
| As hypoth.     | 300              | 2,47712                                                  |
| Is to radius   | 90               | 10,00000                                                 |
| So is A B      | 58.6             | 1,76790                                                  |
|                |                  | <hr/> 11,76790                                           |
|                |                  | 2,47712                                                  |
| Co-sine ang. B | $78^{\circ} 44'$ |                                                          |
| Add E. by N.   | 11 15            | 9,29078                                                  |
| Sum E.         | 89 59 N.         | or the course is N. from B, the westernmost ship's port. |

## CASE V.

The bearings of two or more places from two different stations, as also the bearings and distance of the said stations from each other being given, to find the bearings and distance of the said places from each other.

This case is a compound of the 1st and 3d case aforegoing.

## EXAMPLE I.

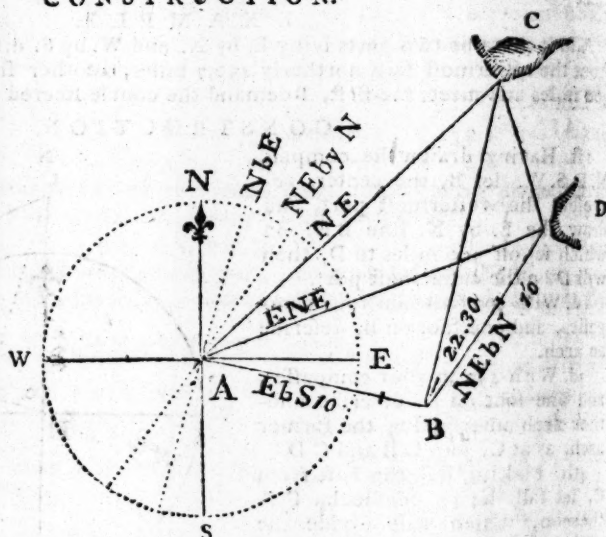
Coasting along shore, I saw two headlands, the first bore from me N. E. the second E. N. E. and after I had sailed E. by S. 10 miles, the first bore from me N. by E. and the second N. E. by N. I demand the bearings of the two headlands from each other?

## CONSTRUCTION.

1st. Having drawn the compass N. E. S. W. let A represent the place of the ship, from whence draw the N. E. line A C, the E. N. E. line A D, and the E. by S. line A B = 10 miles, then will B be the second ship's station.

2d. From B draw the line B C parallel to the N. by E. where this intersects the N. E. line, as in C, gives the first head-land.

3d. Also from B draw the line B D parallel to the N. E. by N. where this intersects the E. N. E. line, as in D, gives the second head-land.



4th. Join the points C and D, then will C D be the distance of the head-lands from each other, and the  $\angle A C D$  their bearing from the N. E. line, to find which by

## CALCULATION.

First you must find the distance of both head-lands from both stations.

1. In the  $\triangle A B C$  all the  $\angle$ s are given, and one side A B 10 miles.

Between E. by S. and N. by E. are eight points, consequently the  $\angle A B C$  is right-angled.

Between N. E. and E. by S. is 5 points, or  $\angle C A B = 56^{\circ} 15'$ . Its comp. =  $\angle A C B = 33^{\circ} 45'$ . In  $\triangle A C B$ .

As sine  $\angle A C B = 33^{\circ} 45' = 9,74474$

: side A B = 10

:: sine  $\angle C A B = 56^{\circ} 15' = 9,91985$

: B C = 149 7

or 15 miles nearly,

2. In the  $\triangle A D B$

Between E. N. E. and E. by S. = 3 points =  $\angle D A B = 33^{\circ} 45'$ .

Between E. N. E. and N. E. by N. is 3 points, so that the  $\angle A D B = 33^{\circ} 45'$ , now there are 2  $\angle$ s equal, consequently there must be two sides equal, viz. the side A B = the side B D = 10 miles; and the  $\triangle A B D$  is an isosceles  $\triangle$ .

180

22 30

2) 157 30

78 45



Lastly, In the  $\triangle CBD$  is given the side  
CB 14.96, the side BD 10 miles, and  $\angle CBD$   
For betwixt the N. by E. and N. E. by N.  
is 2 points, or the  $\angle CBD = 22^\circ 30'$ .  
Assum of sides BC & BD = 24.96 1,39724

: diff. sides BC and BD 4.96 0,69548  
: tang.  $\frac{1}{2}$  sum opp.  $\angle s = 78^\circ 45'$  10,76134

: tang.  $\frac{1}{2}$  difference 44 58

$\angle CDB$  123 43

$\angle CBD$  33 47

As sine  $\angle CBD$  33 47 9,74512

: to BD 10 0 1  
: : sine  $\angle CBD$  22 30 9,58284

: CD = the distance of both 68,82 1,83772

Again,

From  $\angle BCD = 33 47$

Subtract N. by E. 11 15

22 32 that is CD bears

from C S. 22 32 E. or S. S. E. and con-  
trary from D.

### *The Manner of Surveying Coasts and Harbours.*

HAVING, in the former part of this work, treated on those branches of knowledge which ought to be acquired by every one who undertakes the conducting of ships to remote parts; I think it incumbent on me to give some directions concerning another branch, which, though of great importance, seems to be too much neglected; namely, the drawing of Drafts or Charts of the several Coasts along which they sail, and also of those Harbours into which they go.

Those who have the charge of conducting ships frequently complain, that few of the sea charts are found to be correct. Supposing the complaint to be justly founded, we may reasonably presume, that such incorrectness has arisen from the following causes; namely, the Authors having too much recourse to those charts which were drawn when the latitudes and longitudes of places were but ill determined, and when the necessary instruments were not sufficiently correct for the purpose of taking the different bearings; or it may have been owing to an impropriety in the manner of surveying the several parts.

When a voyage is finished, the Journal of that voyage, however applicable it may be to public purposes, is seldom regarded. Were the Lords of the Admiralty to establish a Repository for observations, drawings, appearances of the land, and other useful articles, such materials might be applied to the improvement of navigation. Proper persons might be appointed to arrange and apply them in the constructing of useful sea charts; and such charts, if not given to the public, should be delivered to the officers in the Royal Navy. When a ship of war is ordered to go abroad, the Master who has the charge of navigating her, is under a strong temptation, not to say necessity, to purchase such charts as will best suit his present circumstances, though not the most correct; and the valuable ship, with the still more valuable lives of the people on board, are thereby greatly hazarded.

Having some time ago waited on the First Lord of the Admiralty, I took the liberty to recommend the furnishing of the masters with proper charts, when ordered upon distant services; and observed, that such charts might be returnable in the same manner as the ship's stores are now; which has long been the custom in France. His Lordship thought proper to say, "He hoped the Admiralty would think of it." I told his Lordship, that

L 1 2

I was

I was then speaking to the *First* Lord of the Admiralty, and a Seaman. —Having never heard any thing of the matter since, I shall proceed to shew the reader how the business of taking the bearing of any part of a coast, and of plotting or delineating it, may be performed.

1. Bring the ship to the most convenient place from whence you can see the most distinguished points of land, and the most remarkable objects on shore, and note their bearings down in your station book, as also keep a rough draft on a sheet of paper, note thereon the Station 1.

2. Bring the ship to the next most convenient station or spot you find, and take the bearings of the most remarkable points and spots you before observed when at first station, and obtain if you can the distance of your vessel, from your first station, from the bearings and distance of some noted points on shore, it will be preferable; but if you have no distances on shore of objects from one another, you must, in this case, obtain it carefully by your log; also note these bearings down in your rough draft as well as in your book, making a base line to represent the bearing of your ship at her first station, and placing from some scale thereon the distance and bearing of your former station, which will be station 2, from whence draw the last mentioned bearings, and note their intersections with the same objects before seen; a line drawn through all these intersections, making it resemble as much as you can all the turnings and windings of the land you see, carrying your eye from point to point on shore, and making the same wavings or windings in your draft.

3. Note particularly on shore such remarkable objects that lie in one line, for objects that are in leading marks, as houses, churches, steeples, mountains, &c.

As also such particular objects as open from one another, one, two, or three points or more, it will assist to correct thereby.

4. If you can from a third station take in like manner the bearing and distance of your former two stations, and also of all the former objects, you will from thence be able to detect if any error should have been committed; each station should be if possible in the bearing of two remarkable spots in one, what opening these make with one another at 3d station, will determine.

#### *To take a Draft of a Coast in sailing along Shore.*

HAVING brought the ship to the most convenient place from whence the principal points of the Coast or Bay may be seen, either cast anchor if it is convenient, or lie as steady as possible; or, if the coast is too shoal, let the observations and measures be done in a boat, then, while the vessel is in a stationary situation, take with the azimuth compass, or sextant, the bearings in degrees, &c. of such points of the coast as form the most material projections or hollows, write down these bearings, and make a rough sketch of the coast, observing carefully to mark the points whose bearings were taken with letters, for the sake of reference.

Then let the ship or boat run in a direct line along, which must be carefully measured by the log, or otherwise, one two, or three miles, more or less until she comes to a situation from whence the same points before observed can be seen again: there let the vessel lie as in the foregoing station, and again observe the respective bearings and leading-marks where two points or bearings, as mountains, churches, trees and houses, any two remarkable

remarkable objects in one, in degrees, &c. of the same noted points, which are also to be wrote down, and a rough sketch of the coast should be also taken from this station, for which purpose prepare an observation table, in which write distinctly and regularly the several celestial observations, bearings, distances, measured by the log line, the rocks, shoals, foundings, overfalls, races of tides, and other remarks that may be made along the coast; the table may consist of 7 or 8 columns disposed in the following order:

Note. The sextant will be found the readiest and most correct instrument to take the angles, by being held in an horizontal position, by which means any two objects not exceeding  $120^{\circ}$  may be brought into contact; it will not be amiss to take material points by the compass, and intermediate ones by the sextant or quadrant.

Observations in Navigating the Coast of —, from Cape —, to Point —, being — Miles, measured by the Log, the Course from Station I. to II. being  $S. \frac{1}{4} W.$

| Year, Month and Day. | Meridian Altitude of ☉ | Bearings at Station I. | Time and Distance sailed from Station I. | Bearings and Distances taken at these Distances. | Bearings of Rocks, Shoals, and these estimated Distances, when on a Line with the Points or Heads of the Coasts. | Remarks on the Tides and the Nature and Dimensions of Rocks, Shoals, and Anchorage.                          |
|----------------------|------------------------|------------------------|------------------------------------------|--------------------------------------------------|------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
|                      | D M                    |                        | H. M. Mi.                                | Fath.                                            | Points and Heads.                                                                                                | M.                                                                                                           |
|                      |                        |                        | 1 27 4<br>11 45 5                        | A.N. $5^{\circ} W.$ 22<br>B.W. $20^{\circ} S.$   |                                                                                                                  | This rock is dry at low Water, and seemed 100 Yds. in length, from N. W. to S. W. a leading Mark to it is. — |

In like manner proceed to the second Station, and so on, until the whole Survey is completed.

While



While the vessel is running the base line from station to station, an accurate appearance of the coast should be made, to do which let four expert persons be appointed, one to take the bearing exactly with an azimuth compass; one to oversee the running out of the log line, and to keep an account of the ship's way, so as to be readily able to tell the distance run when required; the third to attend the heaving of the lead, to write down the soundings and bearings of one or two head points, or remarkable points of the coast, taken at each depth; the fourth a draftsman, to draw out the necessary bearings and distances, and delineate the figures and windings of the coast at each station, and to correct their forms and dimensions when the ship is sailing along the land. Then let the several bearings be corrected by the variation to reduce them to their true positions: then, in some convenient part of a sheet of paper, describe a circle, the larger the better, on which lay off the several bearings taken from the first station, and let them be numbered 1, 2, 3, &c. On the outside of the circle; also lay down the several bearings taken at the 2d station, let these be numbered with the same figures on the inside of the circle.

Draw a line to express the ship's run, both in length and course, and from the end of the line, expressing the first station, draw lines parallel to the respective bearings taken at that end, and note it in the circle, mark the intersection of each pair of lines, directed to the same point with the numbers annexed to their bearings; and through the intersection so marked, draw by hand a curved line, observe to wave the line in and out, as near as can be like the bending of the coast itself.

Against each part draw the appearance of the elevated or low ground in the sketches, distinguishing rocks, cliffs, or high lands, low lands, sand hills, &c. If there are any currents, or eddies, express them in their proper places, by darts or arrows, the points being turned that way the currents sets, put in the several soundings at low water, in small figures distinguishing whether fathoms, or feet; shew the time of high water on the full and change days, by Roman figures, and tell the rise in feet, put in a compass, with a scale of miles or leagues, such as the vessel's run was laid down by; add the name of the place, the coast, and the latitude and the longitude, as true as can be obtained.

If there is a shoal or sands on the coast let it be taken by a boat sailing round it, and keeping an account of the courses, distances and soundings, to be put in the draft, the boat must from some part of the sand or shoal, take the bearings of two points on the coast, where bearings have been taken from the ship, or the bearing of the boat or some part of the shoal, or of some beacon in that place must be taken by ship, at the stations where she takes the bearings of the shore, for by either of these means one point of the sand being obtained, the rest of it can be laid down from the boat's account.

If the coast to be drawn is a bay or harbour winding in such a manner, that all its parts cannot be seen at two stations; let as many bases or lines be drawn and exactly measured, as may be found necessary observing that, the several distances run should join to one another, in the nature of a traverse; that each new set of objects, or points observed, should be taken from two stations at the end of a known distance, and that the objects whose bearings are taken, do not so much extend beyond the limits of the base, as to make angles with it less than about  $\frac{1}{4}$  or  $\frac{3}{4}$  of a point, but rather reserve such objects for the next measured base line; for

for when lines lie very obliquely to one another, their interfections are not easily ascertained.

Thus may a coast of any extent be surveyed, by carefully measuring of stationary base lines, and from their ends drawing angles to each other.

If any particular parts of the harbour cannot be conveniently seen from either stations, take the boat into those places, and having well examined them, make sketches thereof, estimating the length and breadth of the several inlets, either by the rowing or sailing of the boat, take as many bearings, soundings, and other notes, as may be thought necessary; then annex these particular views in their proper places in the general draft.

If there are any dangerous sands or rocks, besides inserting them in their proper places, there should be a double line drawn through that point, on one or more objects ashore; and for this purpose choose a church, mill, house, noted tree, a clift, or any remarkable thing that can be distinctly seen at sea, and which can be brought to bear in the same right line with the point to be avoided; but if that point is under water, there must be two land marks brought to bear with the danger, either in a right line, when it can be, or in two lines, and those two lines, and that those land marks may be put down in their proper places, by their interfection of two objects in one bearing, and two objects in another bearing; which will give the station of the ship; and the distance, and the bearing of the danger from that station noted, when near or on it, but if two such interfections cannot be obtained, it must be put down from the two points on shore in one with the computed distance therefrom, or from the interfection bearings of two single points on shore.

It should be remarked in the draft, what places, if any, are unfit for anchorage, and what are fit, by writing rocky ground, foul anchorage, good anchorage; and in the latter, to draw the figure of an anchor. Also, if there is any particular channel more convenient to sail through than another, it is to be pointed out by lines drawn to its entrance, from two or more noted marks on shore.

The foregoing method of surveying a coast, supposes in general, that it is taken by a ship in her passage along, not having an opportunity of going ashore.—But when circumstances will permit the measures and observations to be made on land, the survey can be more accurately taken than on the water.

### *To Survey an Harbour by Observation ashore.*

**MAKE** an eye-draft of the place to be surveyed; and in going round its coast fix in the most remarkable points and bends of the shore, station, staves, or strait poles, tall enough to be seen at a considerable distance: but if at any of those places there is a noted tree, house, or any other remarkable thing, that object may serve instead of a station staff; and it will be convenient to black the staves, and tie a piece of white bunting to the top of each: then in the eye-draft put letters at the noted points, or marks, for distinction sake.

Choose the most level spot of ground, wherein a base line may be measured, of one more half miles in length, or a length of not less than a tenth part of the distance of the two extreme objects marked for observing, and let the direction of the measured base line be so laid out, that from both ends of it as many of the station staves before planted, or the objects before

remarked,

remarked, may be seen; the bearing or position of this base must be determined by degrees and minutes, and also its length must be accurately measured to feet and parts, either by a measured chain, or by a piece of log line of 100 feet long, properly marked at the end of every 10 feet.

From one end of the base observe, with any instrument proper to take bearings, the position or bearing in degrees and minutes, of all the staves or objects within view, and write them down orderly, do the same from the end of the base, and let all the bearings be corrected by the variation of the compass.

Then these measures and corrected bearings being plotted or laid down, will give the most conspicuous points on shore, the intermediate spaces are to be filled up from the sketches of them made on the spot.

But if any such objects should spread on either hand, so far from beyond the limits of the base, that at either end thereof, the other end and those objects or staves should appear nearly in the same direction, or to make  $<^{\circ}$  of, not exceeding  $10^{\circ}$ . Or, if some of the remarked objects can be seen only from one end of the base, then let the bearings of such objects be taken from a place whose position has been determined from both ends of the measured base; or if there are several remarked objects which cannot be seen from neither end of the base lines, let the bearings of such objects be taken from each of the two points whose position has been taken from both ends of the base, or it may on some occasions be proper to choose another place on which another base of a convenient length may be measured, and from the extremities of which the ends of the first base may be seen, and also as many as can be of the remaining objects which lay too obliquely for the first base, or which could not be seen from it, in such manner proceed until the bearings are taken of all the points judged necessary for completing the survey of the limits of the harbour.

If a base line of a sufficient length cannot be measured in one right line, it may be taken in two adjoining lines, as the two sides of a triangle, the included angle being accurately taken, and the bearing of either line.

When the outlines or limits of an harbour, bay, road, &c. are delineated by the preceding precepts, let a small vessel go out to sea to take drawings of the appearance of the land, and its bearings, sail likewise into the harbour, and draw the appearance of its entrance, take particular notice if there are any false resemblance of the entrance by which ships may be deceived and run into danger; or when any two objects being brought in a line or in one, will lead into the harbour without danger; when it can be done, search for the best anchoring places, and, if possible denote those places by bringing two objects in one, if not the exact bearings bearings of two or three other objects, so that the places may be easily determined, the chart being correctly drawn, a compass, with the variation, and scale, properly fitted to the plan, the isles, rocks, sands, &c. marked in their proper places, with their soundings at low water, and the winds open to them, the best track with the soundings all the way to those anchoring places, the proper sailing marks to avoid dangers; the winds, if any troublesome ones, which prevail, and at what seasons; the places where fresh water can be got, the name of the place, the country in, on what sea, the latitude and longitude, a sketch of the appearance of the place makes at sea upon a known rhumb, and at an estimated distance, and whatever else a judicious seaman shall think proper to insert, then is the plan fit for all nautical purposes, and may be embellished with proper colours if necessary.



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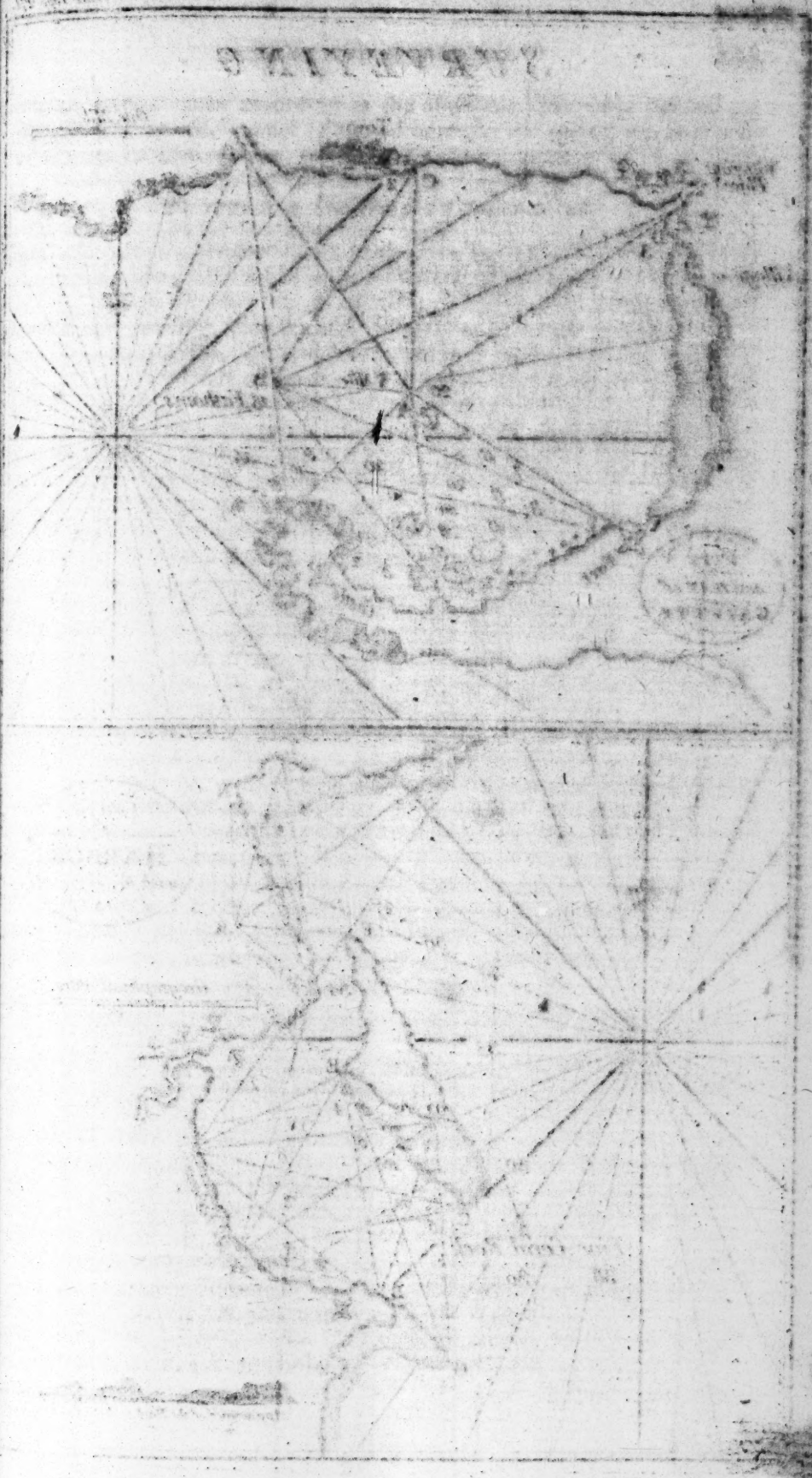
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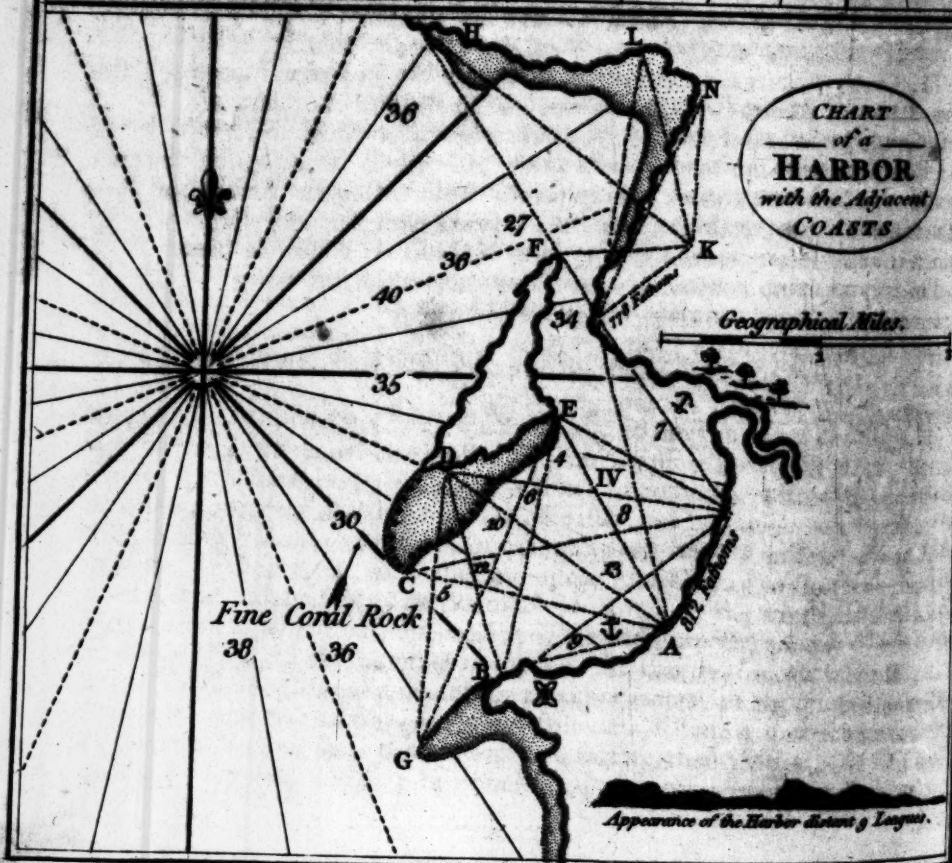
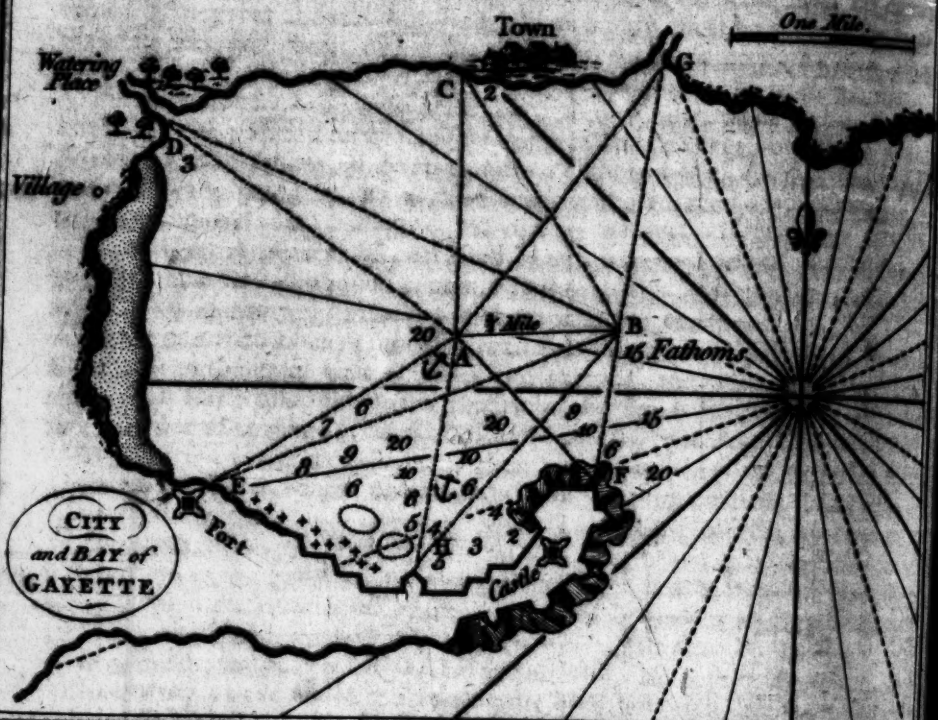
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# SURVEYING



Appearance of the Harbor distant 9 Leagues.

Sea-drawings, taken according to the foregoing precepts, besides the real use they are of, cannot fail to recommend the young mariner who surveys and constructs them, to the notice of his superiors.

*To reduce a Draft to a smaller Scale.*

WITH a black lead pencil draw the draft to be reduced all over with cross lines, forming exact squares, draw the clean paper for the copy all over with the same number of squares, but their sides larger or smaller in proportion to the intended size of the scale, such as  $\frac{1}{2}$ ,  $\frac{1}{4}$ , &c. length of the other, distinguish by a stronger mark, with a figure every fifth or sixth row of squares in both, so that the several corresponding squares may be readily perceived, then in each of the squares of the draft, draw by the eye a curve on the paper similar to that in the square of your copying draft, till the whole is copied, make the black lines with India or other ink, and when drawn, the black lead lines may be rubbed out with bread or India rubber.

I here give two Examples as an elucidation of what has last been said.

EXAMPLE I.

AB is the Base Line, equal to  $\frac{3}{4}$  Mile.

|                                   |   |                                 |                        |   |                                 |
|-----------------------------------|---|---------------------------------|------------------------|---|---------------------------------|
| BG = N. $5^{\circ}$ E.            | 1 | } Station at B<br>with bearings | AG N.E. by N. 1        | 1 | } Station at A<br>with bearings |
| BC N. $25^{\circ}$ W.             | 2 |                                 | AC N.                  | 2 |                                 |
| BD N. $53^{\circ}$ W.             | 3 |                                 | AD S. by W.            | 3 |                                 |
| BE W. S. W.                       | 4 |                                 | AE S. W. by W.         | 4 |                                 |
| BH — S. W. by S. $\frac{1}{2}$ W. | 5 |                                 | AH S. $\frac{1}{2}$ W. | 5 |                                 |
| BF — S.                           | 6 |                                 | AF S. E.               | 6 |                                 |

These instructions give the points GC DE HF in order from each station; that is, BG and AG intersects, as also BC and AC, &c.

Observe, the last letter must be the same in both bearings, and it will be best to follow the bearings one way all round the compass from the first station; as also when arrived at the second station, begin with your first object seen at first station, and follow the letters round belonging to each object, by which the last letter in each bearing will successively follow in order.

This is an example when on board ship, but in the following

EXAMPLE II.

This harbour was surveyed from base lines taken on shore, which, when it can be done, is far preferable.

The base line AB 812 fathoms was taken, as by directions, on the most even spot on shore; now beginning from the point A.

|                              |                               |                                 |                               |
|------------------------------|-------------------------------|---------------------------------|-------------------------------|
| AB W. by S. $\frac{1}{2}$ S. | } Bearings from<br>Station A. | GB S. S. W.                     | } Bearings from<br>Station G. |
| AC W. by N.                  |                               | GC W. by S. $\frac{1}{4}$ S.    |                               |
| AD W. N. W. $\frac{3}{4}$ N. |                               | GD W. $\frac{3}{4}$ N.          |                               |
| AE N. N. W. $\frac{3}{4}$ W. |                               | GE W. N. W. $\frac{1}{4}$ N.    |                               |
| AF N. by W. $\frac{1}{2}$ W. |                               | GF N. W. by N. $\frac{1}{4}$ N. |                               |
| AG N. N. E. — —              |                               |                                 |                               |

812 fathoms.

Bearings from Station F.

|                                                |
|------------------------------------------------|
| FE and FH N. W. by N. $\frac{1}{4}$ N. in one. |
| FI N. $\frac{1}{4}$ E.                         |
| FK N. E. $\frac{1}{4}$ E. 773 fathom.          |

Bearings from Station K.

|                              |
|------------------------------|
| KF S. W. $\frac{1}{4}$ W.    |
| KE W. $\frac{1}{2}$ S.       |
| KH N. W. $\frac{3}{4}$ N.    |
| KT N. by W. $\frac{1}{2}$ W. |
| KN N. $\frac{1}{4}$ E.       |

M m

Through



Through the intersections of the bearing draw the configuration of the land, as before directed, and finish the drawing by the instructions there given, which if well heeded no difficulty will materially occur.

*To find the Height and Distances of Objects at Sea.*

**W**HEN the object is perpendicular, and the distance to it can be measured, find the angle of altitude with a quadrant, and measure the distance to it as exact as possible, then you have the  $\angle$  and base, to find the perpendicular; or if you go backward or forward until the angle of altitude be  $45^\circ$  the distance between you and the object, will be the perpendicular height.

**EXAMPLE I.**

Being 96 fathoms from the bottom of a tower, I find its altitude, after allowing for the height of my eye, above the water  $15^\circ 10'$ . Required the height?

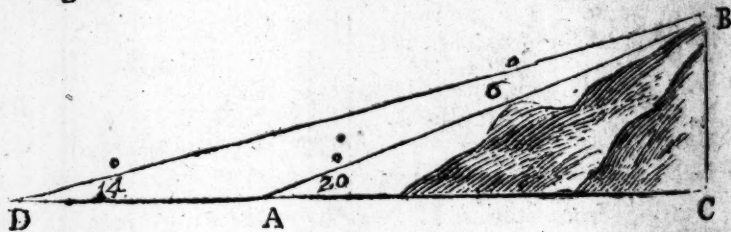


Draw  $AB = 96$  upon B erect the perpendicular  $BC$ , and draw  $AC$ , making an angle with  $AB = 15^\circ 10'$  till it cuts  $BC$  in  $C$ , then will  $BC$  be the height of the tower.

|                                   |          |
|-----------------------------------|----------|
| As radius                         | 10.00000 |
| Is to the distance 96             | 1.98227  |
| So is tang. ang. A $15^\circ 10'$ | 9.43308  |
| To the height $BC$ 26.2           | 1.41535  |

**EXAMPLE II.**

Being at sea, I observed the altitude of a mountain, and found it  $20^\circ$ , and then sailing from it in a direct line four miles, I found the altitude of the mountain to be  $14^\circ$ , dip and refraction allowed for. I require the perpendicular height?



CON

CONSTRUCTION.

Draw the horizontal line DC

On any point A make the  $\angle BAC = 20^\circ$ , from A set off 4 miles to D, on D make the  $\angle BDC = 14^\circ$ , and from where the line DB cuts the line AB as at B, let fall the perpendicular BC on the base DC, and DC measured will be the perpendicular height required.

$$\begin{aligned} \angle A &= 160^\circ \\ \angle D &= 14^\circ \end{aligned}$$

Sum  $174^\circ$  which taken from  $180^\circ$  gives the  $\angle DBA = 6^\circ$  Then it will be As sine  $\angle DBA = 6^\circ$

$$\begin{aligned} &: BB = 4 \text{ miles} & 0.60266 \\ &:: \text{Sine } \angle BDA = 14^\circ & 9.38368 \end{aligned}$$

$$\begin{aligned} &9.98574 \\ &9.01923 \end{aligned}$$

$$: AB = 9.258 \quad = 0.96651$$

Then  $\triangle ABC$  given  $AB = 9.258$  and  $\angle A$  find BC.

|                      |         |
|----------------------|---------|
| Radius               | 10      |
| : AB 9.258           | 0.96651 |
| : : Sine $\angle 20$ | 9.53405 |
| : BC = 3.166         | 0.50056 |

So that the height of the mountain is 3 miles  $\frac{166}{100} = 1$  furlong 13 poles, &c.

NOTE. In finding the  $\angle DAB$  see prop. 5th. in Geometry.

*Of the Curvature of the Earth.*

MOST persons know, that if they are raised above the surface of the adjacent land or water, they can not only see different objects that lie on that surface better, but also see those more and more remote as they advance higher. The irregularity of the surface of the land will not be subjected to any one rule that will give the distance to which objects may be seen at different elevations; but at sea, where there is generally an uniform curvature of the water, upon the supposition of the spherical form of the earth, those distances may be easily computed.

R U L E.

To the earth's semidiameter add the height of the eye, multiply the sum by the height, then the square root of the product is the distance at which an object on the surface of the water can be seen by an eye so elevated; and by this rule was the table XXIII. computed, the diameter of the earth being taken at 41798117 feet, according to Sir Isaac Newton's measures. This table may be usefully applied to estimate the distance of an object at sea, the elevation of that object above its horizon being known.

EXAMPLE I.

Sailing towards a head-land, on which is a light-house elevated 600 feet above the surface of the water, we saw the lights at night just appear in the horizon, how far were we at that time distant from that light-house?

Look in table XXIII. for 600 feet in the column marked height in feet, and right against it, in the column marked distance in miles, is 29.994. So that the distance may be reckoned about 30 miles.

## EXAMPLE II.

Being in company with some merchants walking on a sandy shore, on the look-out for a vessel which was expected, whose top-gallant mast was 140 feet above the surface, allowance being made for her immersion in the water, we observed through the telescope a ship's vane just appearing in the horizon, How far off is that ship, supposing it the vessel expected? Answer, Against 140 feet, the height, stands 14.488, that is her distance; here is no allowance made for the height of the eye above the horizon; but it is obvious, that the higher the eye, the farther it can see: now as objects are seen in a strait line, and that line is a tangent to the earth's surface, therefore it follows, that to find the distance of two elevated objects, when the right line joining them touches the surface of the earth, between those objects look for the distance answering each height, and their sum is the distance required.

Thus, in the second example, suppose the eye raised six feet above the water edge, it can see an object on the surface 2.999, or 3 miles off. This distance added to  $14\frac{1}{2}$  miles, makes the distance of the ship to be  $17\frac{1}{2}$  miles.

## EXAMPLE III.

A man being on the main top gallant mast of a man of war 200 feet above the water, sees an 100 gun ship she had engaged the day before hull-to, how far were those ships dist. from one another.

A ship of 100 guns, or a first rate man of war, is above 60 feet from the keel to the rails from which deduct about 20, leaves 40 for the height of her quarter above water. Now a ship is seen to hull-to when her upper works just appear.

|                          |                                |
|--------------------------|--------------------------------|
| Then 200 feet high gives | 17.316 miles.                  |
| And against 40 stands    | <u>7.744</u>                   |
|                          | 25.060 miles, is her distance. |

## CURRENT SAILING.

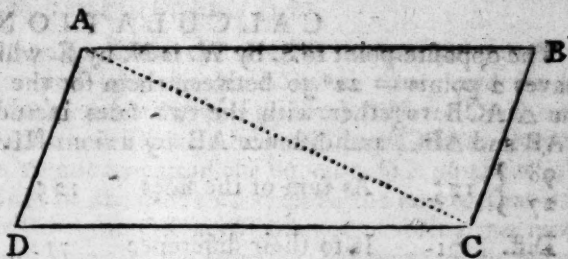
**C**URRENTS are certain settings of the stream, by the means of which all bodies moving therein are compelled to alter their course, and submit to the motion impressed upon them by it; whence, if a current sets with the course of a ship, it augments her motion by as much as the drift or rate of driving it.

Thus, if a ship sails N. N. E. 20 miles in a current that sets N. N. E. 8 miles, in the same time her true course will be N. N. E. 28 miles in that time; but if a current sets against the ship, it lessens her velocity by just as much as the current's drift is.

So that if the ship sails N. E. 49 miles, in a current that sets S. W. 10 miles in that time, then her true course will be N. E. 39 miles; and if in the same time that the ship sails N. E. 49 miles in a current that sets S. W. 59 miles, then the ship will fall astern, and her true course will be S. W. 10 miles; but if the ship thwarts the current, it not only lessens or augments her velocity, but gives her a new motion, compounded of that of the ship and current, that is,



If a body be agitated by two motions at the same time, the one with a certain velocity that will carry it according to the direction of the line AB, the length AB in a certain space of time, the other according to the direction of the line AD, with a velocity that will carry it to the distance AD in the same time, then the body will describe the diagonal AC, and at the end of that time will be found in the point C.

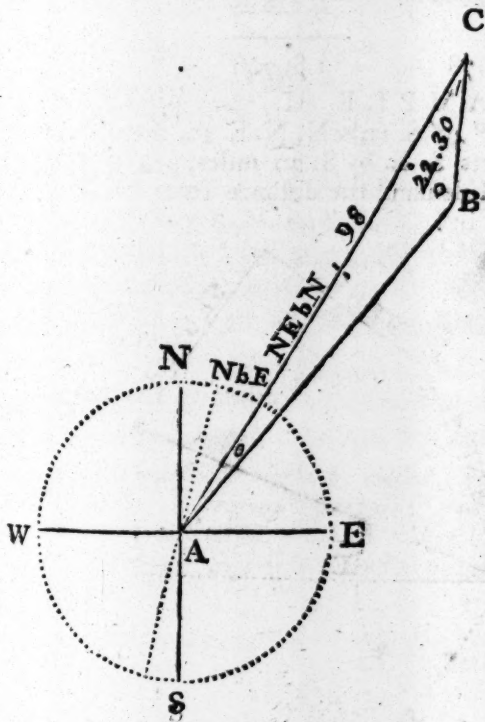


The setting and drifts of the most remarkable tides and currents are pretty well known, but if in unknown currents, the usual way to find the setting and drift is thus:

Let three or four men take a boat a little way from the ship, and by a rope fastened to the boat's stern, let down an heavy iron pot, or loaded kettle, into the sea, to the depth of 80 or 100 fathoms when it can be, whereby the boat will ride almost as steady as at anchor, then heave the log, and the number of knots run out in half a minute, will give the miles which the current runs per hour, and the bearing of the log shew the setting of the current.

## EXAMPLE I.

If a ship sails 98 miles N. E. by N. in a current, that sets S. by W. 27 miles in the same time. What is her true course and distance?



$$\begin{array}{r}
 180 \\
 22\ 30 \\
 \hline
 2)157\ 30 \\
 \hline
 78\ 45
 \end{array}$$

## CALCULATION.

The opposite point to S. by W. is N. by E. which taken from N. E. by N. leaves 2 points =  $22^{\circ} 30'$  between them for the  $\angle C$ , being thus given in the  $\triangle ACB$  together with the two sides including it AC CB to find  $\angle CAB$  and  $ABC$ , and distance AB by axiom III.

|          |                                                            |     |          |
|----------|------------------------------------------------------------|-----|----------|
| 98 } 125 | As sum of the sides                                        | 125 | 2.09691  |
| 27 }     |                                                            |     |          |
| Diff. 71 | Is to their difference                                     | 71  | 1.85126  |
|          | So is tang. $\frac{1}{2}$ sum opp. $\angle 78^{\circ} 45'$ |     | 10.70134 |
|          |                                                            |     | 12.55260 |
|          |                                                            |     | 2.09691  |
|          | To tang. $\frac{1}{2}$ their difference 70 42              |     | 10.45569 |

|              |        |
|--------------|--------|
| $\angle B =$ | 149 27 |
| $\angle A =$ | 8 3    |
| $\angle C =$ | 22 30  |

Sum  $\angle = 180^{\circ} 0'$

To find the Distance by Axiom I.

As sine  $\angle A$   $8^{\circ} 3' = 9.14624$

Is to CB 27' 1.43136

So is sine  $\angle C$   $22^{\circ} 30' = 9.58284$

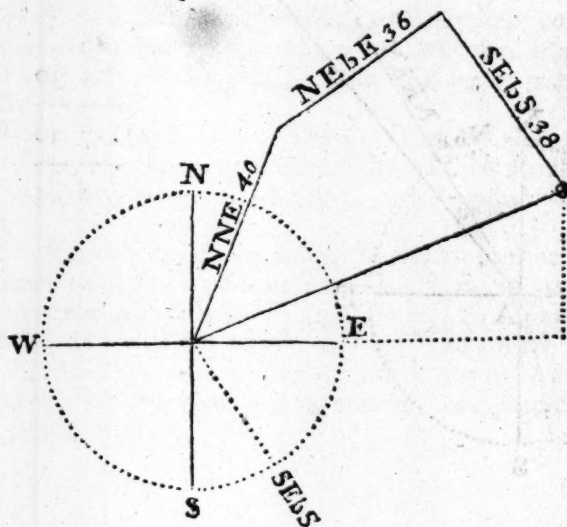
11.01420

9.14624

To distance AB 73.78 1.86796

## EXAMPLE II.

If a ship from the latitude  $38^{\circ} 40'$  S. fails N. N. E. 40, then N. E. by E. 36 miles, in a current that sets S. E. by S. 20 miles, in the same time that the ship fails 40 miles; I demand the distance from her first place, and also the latitude the ship is in?



CON.

## CONSTRUCTION.

Having drawn the compass, draw the N. N. E. course equal to 40 miles, to the end of which join the N. E. by E. line, and set off thereon 36 from the same scale, from the end of the last N. E. by E. line set off the distance the current's drift, viz. S. E. by S. 38' miles, that is, as 40, the stern of the ship, to 20 the run of the current, so is 76 the whole run of the ship to 38 the drift of the current, then to the end of that line to the ship's first place, will be the distance, and the  $\angle$  being measured will be the ship's course, and a line let fall from this last point on the parallel of the ship's first place, will give on that parallel the departure from her first meridian.

This may be done by calculation, but that being tedious, we shall omit it, and shew how it may be done by a traverse, in which we shall consider the current as a single course.

| Courses     | Miles | Northing | Southing | Easting | Westing |
|-------------|-------|----------|----------|---------|---------|
| N. N. E.    | 40    | 37.0     |          | 15.3    |         |
| N. E. by E. | 36    | 20.0     |          | 29.9    |         |
| S. E. by S. | 38    |          | 31.6     | 21.1    |         |
|             |       | 57.0     | 31.6     | 66.3    |         |
|             |       | 31.6     |          |         |         |
|             |       | 25.4     |          |         |         |

|                                                                                         |      |          |
|-----------------------------------------------------------------------------------------|------|----------|
| As diff. lat.                                                                           | 25.4 | 1.40483  |
| Is to radius                                                                            |      | 10       |
| So is dep.                                                                              | 66.3 | 1.82151  |
| To tang. course $69^{\circ} 3'$ from N. Easterly<br>or nearly E. N. E. $\frac{1}{4}$ E. |      | 10.41668 |
| As fine of course $69^{\circ} 3'$                                                       |      | 9.97030  |
| Is to dep.                                                                              | 66.3 | 1.82151  |
| So is radius                                                                            |      | 10       |
| To distance 70 miles                                                                    |      | 1.85121  |

Many more questions might be added, but these, being well understood, are sufficient for the seaman's purpose; and that the student should not meet with any thing unnecessary which might lead him out of the plain path, I have avoided those things which tend to puzzle more than improve.

EXPLA-



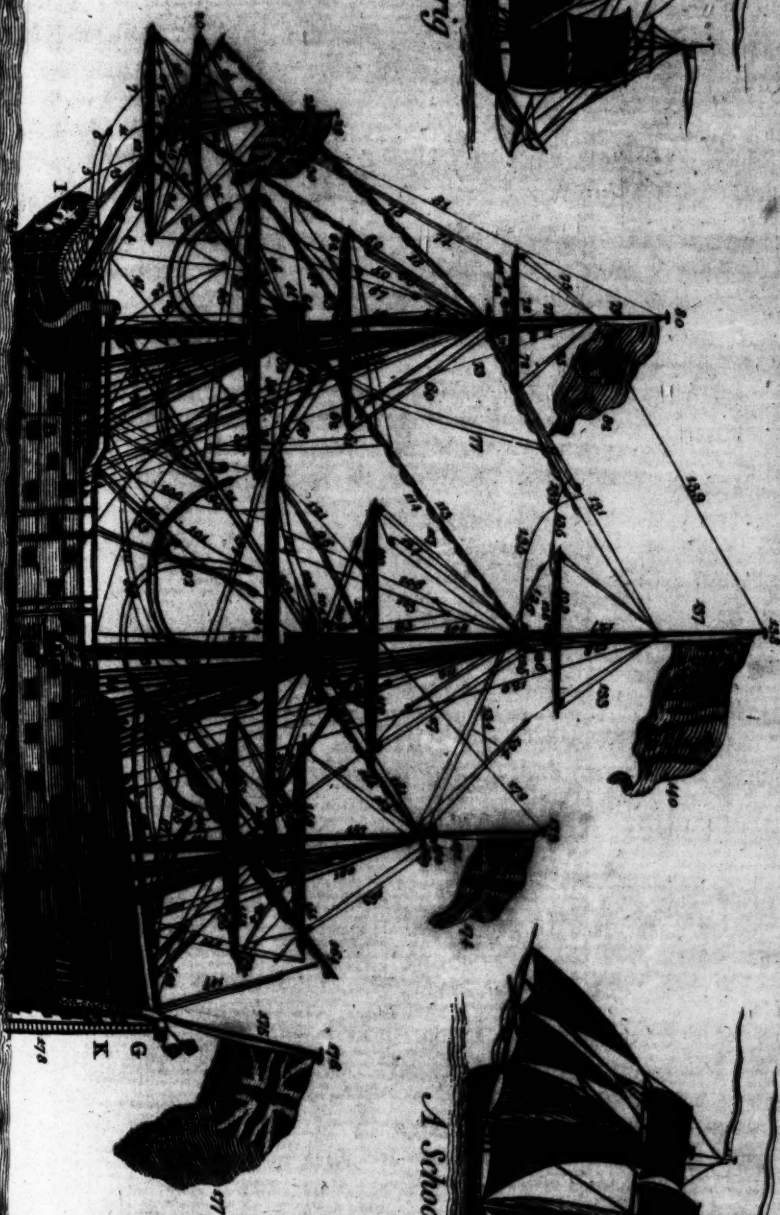
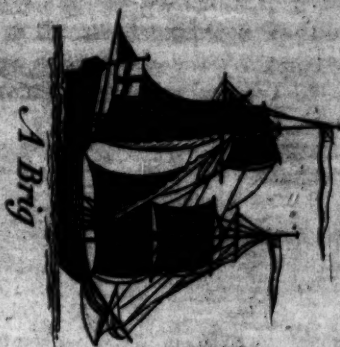
# EXPLANATION of the PLATE, describing the RIGGING, &c. of a FIRST-RATE SHIP of WAR.

|                                |                                |                            |
|--------------------------------|--------------------------------|----------------------------|
| 1 BOWSPRIT                     | 65 Reef-tackles                | 129 Yard and fail          |
| 2 Yard and fail                | 66 Sheets                      | 130 Backstays              |
| 3 Gammoning                    | 67 Buntlines                   | 131 Stay                   |
| 4 Horse                        | 68 Crofstrees                  | 132 Stayfail and hallyards |
| 5 Bobstay                      | 69 Cap                         | 133 Lifts                  |
| 6 Spritfail sheets             | 70 FORETOPGALL-MAST            | 134 Braces and pendants    |
| 7 Pendants                     | 71 Shrouds and lanyards        | 135 Bowlines and bridles   |
| 8 Braces and pendants          | 72 Yard and fail               | 136 Clewlines              |
| 9 Hallyards                    | 73 Backstays                   | 137 Flag-staff             |
| 10 Lifts                       | 74 Stay                        | 138 Truck                  |
| 11 Clewlines                   | 75 Lifts                       | 139 Flag-staff stay        |
| 12 Spritsail horses            | 76 Clewlines                   | 140 Flag standard          |
| 13 Buntlines                   | 77 Braces and pendants         | 141 MIZEN-MAST             |
| 14 Standing lifts              | 78 Bowlines and bridles        | 142 Shrouds and lanyards   |
| 15 Spritfail top               | 79 Flag-staff                  | 143 Pendants and burtons   |
| 16 Flying jibboom              | 80 Truck                       | 144 Yard and fail          |
| 17 Flying jib, stay, and sails | 81 Flag-staff stay             | 145 Crowfoot               |
| 18 Hallyards                   | 82 Flag Lord High-Admiral      | 146 Sheet                  |
| 19 Sheets                      | 83 MAIN-MAST                   | 147 Pendant lines          |
| 20 Horses                      | 84 Shrouds                     | 148 Peckbrails             |
| 21 SPRIT-SAIL TOP-MAST         | 85 Lanyards                    | 149 Stayfail               |
| 22 Shrouds                     | 86 Runner and tackle           | 150 Stay                   |
| 23 Yard and fail               | 87 Pendant of the gornet       | 151 Derrick and spann      |
| 24 Sheets                      | 88 Guy of ditto                | 152 Top                    |
| 25 Lifts                       | 89 Fall of ditto               | 153 Cross-jack yard        |
| 26 Braces and pendants         | 90 Stay                        | 154 Cross-jack lifts       |
| 27 Cap                         | 91 Preventer stay              | 155 Cross-jack braces      |
| 28 Jack-staff                  | 92 Stay-tackle                 | 156 Cross-jack flings      |
| 29 Truck                       | 93 Woolding the mast           | 157 MIZZEN TOP-MAST        |
| 30 Jack-flag                   | 94 Jeers                       | 158 Shrouds and lanyards   |
| 31 FORE-MAST                   | 95 Yard tackles                | 159 Yard and fail          |
| 32 Runner and tackle           | 96 Lifts                       | 160 Backstays              |
| 33 Shrouds                     | 97 Braces and pendants         | 161 Stay                   |
| 34 Lanyards                    | 98 Horses                      | 162 Hallyards              |
| 35 Stay and lanyard            | 99 Sheets                      | 163 Lifts                  |
| 36 Preventer stay and lanyard  | 100 Tacks                      | 164 Braces and pendants    |
| 37 Woolding the mast           | 101 Bowlines and bridles       | 165 Bowlines and bridles   |
| 38 Yard and fail               | 102 Crowfoot                   | 166 Sheets                 |
| 39 Horses                      | 103 Top-rope                   | 167 Clewlines              |
| 40 Top                         | 104 Top                        | 168 Stayfail               |
| 41 Crowfoot                    | 105 Buntlines                  | 169 Crofstrees             |
| 42 Jeers                       | 106 Leechlines                 | 170 Cap                    |
| 43 Yard-tackles                | 107 Yard and fail              | 171 Flag-staff             |
| 44 Lifts                       | 108 MAIN TOP-MAST              | 172 Flag-staff stay        |
| 45 Braces and pendants         | 109 Shrouds and lanyard        | 173 Truck                  |
| 46 Sheets                      | 110 Yard and fail              | 174 Flag union             |
| 47 Fore tacks                  | 111 Puttock shrouds            | 175 Ensign staff           |
| 48 Bowlines and bridles        | 112 Backstays                  | 176 Truck                  |
| 49 Fore buntlines              | 113 Stay                       | 177 Ensign                 |
| 50 Fore leechlines             | 114 Stayfail & stay & hallyard | 178 Poop ladder            |
| 51 Fore top-rope               | 115 Runners                    | 179 Bower cable.           |
| 52 Puttock shrouds             | 116 Hallyards                  |                            |
| 53 FORE TOP-MAST               | 117 Lifts                      |                            |
| 54 Shrouds and lanyards        | 118 Clewlines                  |                            |
| 55 Yard and fail               | 119 Braces and pendants        |                            |
| 56 Stay and fail               | 120 Horses                     |                            |
| 57 Runner                      | 121 Sheets                     |                            |
| 58 Backstays                   | 122 Bowlines and bridles       |                            |
| 59 Hallyards                   | 123 Buntlines                  |                            |
| 60 Lifts                       | 124 Reef-tackles               |                            |
| 61 Braces and pendants         | 125 Crofstrees                 |                            |
| 62 Horses                      | 126 Caps                       |                            |
| 63 Clewlines                   | 127 MAIN TOP GAL. MAST         |                            |
| 64 Bowlines and bridles        | 128 Shrouds and hallyards      |                            |

## H U L L.

- A Cat head
- B Fore channels
- C Main channels
- D Mizzen channels
- E Entering-port
- F Haufe-holes
- G Poop lanthorns
- H Cheistrees
- I Head
- K Stern

A FIRST RATE SHIP OF WAR.





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[Though the following may be thought useless to seamen, it may not be so to many teachers and learners, as there are excellent mathematicians who, on account of their being far distant from any sea-port, are at a loss for the terms made use of at sea.]

## AN EXPLANATION OF SEA TERMS.

**Aft, or Abaft.** The sternmost part of the ship: Carry aft any thing; that is, carry it towards the stern. The mast rakes aft, that is, hangs towards the stern. How chear ye fore and aft? that is, how fares all the ship's company?

**Amain.** The old term for yield, used by men of war to an enemy; but it now signifies any thing done suddenly, or at once, by a number of men.

**Aloft.** Over head, or above.

**Anchor.** The instrument by which a ship is held. The anchor is foul; that is, the cable has got about the fluke of the anchor. The anchor is a-peek; that is, directly under the hause-hole of the ship. The anchor is a cock-bill, that is, hangs up and down the ship's side.

**Awning.** A shelter or screen of canvas, spread over the decks of a ship to keep off the heat of the sun. Spread the awning, extend it so as to cover the deck. Furl the awning, that is, roll it up.

**Aloof, is distance.** Keep aloof, that is keep at a distance.

**Avast.** A term used for stop, or stay; as, avast heaving, don't heave any more.

**Athwart.** Across.

**Bale.** Bale the boat; that is, to lade or throw the water out of her.

**Ballast,** is either pigs of iron, stones, or gravel, which last is called shingle ballast; and their use is to bring the ship down to her bearings in the water, which her provisions and stores will not do. Trim the ballast, that is, spread it about, and lay it even. The ballast shoots, that is, it shifts, or runs over from one side of the hold to the other.

**Barge.** A carvel-built boat, that rows with ten or twelve oars.

**Bearing,** signifies the point of the compass which any two or more places bear from each other, or how any place bears from the ship by the compass; or it may be said to bear on the beam, abaft the beam, on the bow, the head or stern, &c.

**Bearings of a ship,** is that line which is formed by the water upon her sides when she is at anchor, with her proportion of ballast, and stores on board. To bear to, is to sail into an harbour, &c. Bear round up; that is, put her right before the wind. Bring your guns to bear, is to point them to the object.

**Bearing-up, or Bearing-away.** The act of changing the course of a ship, in order to make her run before the wind, after she had sailed some time with a side wind, or close hauled: it is generally performed to arrive at some port under the lee or to avoid some imminent danger occasioned by a violent storm, leak, or enemy in sight. This phrase, which is absurd enough, seems to have been derived from the motion of the helm by which this effect is produced; as the helm is then borne up to the windward or weather side of the ship. Otherwise it is a direct contradiction in terms, to say that a ship bears up, when she goes before the wind; since the current of the wind as well as that of a river is always

understood to determine the situation of objects or places within its limits. In the first sense we say, up to windward and down to leeward; as in the latter we say, up or down the river. This expression, however, although extremely improper, is commonly adopted in the general instructions of our navy, printed by authority, instead of bearing down, or bearing away.

**Belay.** To make fast any running rope; as belay the main brace, or make it fast.

**Bend.** To apply to, and fasten; as, bend the sails, apply them to the yards, and fasten them; unbend the sails that is, cast them off, and take them from the yards; her sails are unbent, she has none fixed; bend the cable, make it fast to the anchor.

**Birth.** A place; as the ship's birth, the place where she is moored; an officer's birth, his place in the ship to eat or sleep in; birth the ship's company, that is allot them their places to mess in; birth the hammocks, point out where each man's hammock is to hang.

**Bight of a rope.** Any part between the two ends. Bight, a narrow inlet of the sea.

**Bilge.** To break. The ship is bilged, that is her planks are broken in by violence.

**Binnacle.** A kind of box to contain the compasses in upon deck.

**Bitts.** Very large pieces of timber in the fore part of a ship, round which the cables are fastened when the ship is at anchor. After bitts, a smaller kind of bitts upon the quarter deck, for belaying the running rigging to.

**Bonnet of a sail.** Is an additional piece of canvas put to the sail in moderate weather to hold more wind. Lace on the bonnet, that is fasten it to the sail. Shake off the bonnet, take it off.

**Board.** To board a ship, is to enter it in an hostile manner by force.

**Board and Board,** is when two ships touch each other. To make a board, is making a stretch upon any tack, when a ship is working upon a wind. To board it up, that is, to turn to windward. The ship has made a stern-board, that is, when she loses ground in working upon a wind.

**Break bulk.** To open the hold and take goods thereout.

**Batten.** A thin piece of wood. Batten down the hatches, is to lay battens upon the tarpaulins, which are over the hatches in bad weather, and nail them down, that they may not be washed off.

**Buoy.** A floating conical cask, moored upon shoals, to shew where the danger is; also used to anchors to shew where they lie, in case of the cable breaking.

**Block.** A piece of wood with running sheaves or wheels in it, through which the running rigging is passed, to add to the purchase.

**Braces.** The ropes by which the yards are turned about to form the sails to the wind.

**Bow-sprit.** A large mast or piece of timber which stands out from the bows of a ship.

**Bulk-head.** A partition.

**Bolt-rope.** The rope which goes round a sail, and to which the canvas is sewed.

**Bow-lines.** Lines made fast to the fides of the sails to haul them forward when upon a wind, which being hauled turt, enables the ship to come nearer to the wind.

*Bunt-lines*

**Bunt-lines.** Lines that come down from the top of the mast to the beam of the outside of the sail, and by which the bunt or belly of the sail is hauled up outwards.

**Broach-to.** Is when a ship on a sudden lays her broadside to the sea, and is dangerous in bad weather.

**Chace.** A pursuit. To chace, to pursue. The chace, the vessel pursued.

**Careening.** To bring a ship down on one side, so as to get at the other side to repair or clean it.

**Caulking.** Filling the seams of a ship with oakum.

**Cun.** To direct. To cun a ship is to direct the man at the helm how to steer.

**Course.** The point of the compass upon which the ship sails. Courses, a ship's lower sails; as the fore-sail is the fore course, the main-sail the main course, &c. The ship is under her courses; that is, has no sail set but the main-sail, foresail, and mizen.

**Coxswain.** The person who steers the boat.

**Come no near.** Is said by the man at the cun when the ship is upon a wind, and is coming too near the wind.

**Chains.** A place built on the sides of the ship projecting out, and at which the shrouds are fastened, for the purpose of giving them a greater angle than they could have if fastened to the ship's side, and of course giving them greater power to secure the mast.

**Chain-plates,** are plates of iron fastened to the ship's sides under the chains, and to these plates the dead eyes are fastened by other plates.

**Capstan.** An instrument by which the anchor is weighted out of the ground, it being a great mechanical power, and is used for setting up the shrouds, and other work where great purchases are required.

**Cat-heads.** The timbers on ships bows, with sheaves in them, by which the anchor is purchased from the hawse, and to which it is secured to the ship's side.

**Capsize.** Overturn. The boat capsized, that is overset. Capsize the quail of rope, that is, turn it over.

**Call.** A silver pipe used by the boatswain and his mates when on duty.

**Clew.** To haul up the sails by the clew-lines.

**Clew-lines,** are ropes which come down from the mast to the lower corners of the sails, and by which the corners or clews of the sails are hauled up.

**Crow-foot,** is a number of small lines spread from the fore parts of the tops, by means of the piece of wood through which they pass, and being hauled taut upon the stays, they prevent the foot of the top sails catching upon the top rim; they are also used to suspend the awnings.

**Crank.** The ship is crank, that is, she has not a sufficient cargo or ballast to render her capable of bearing sail, without being exposed to the danger of oversetting.

**Dead-water.** The eddie water at the stern of a ship.

**Douce.** To strike or haul down; as, douce the top-gallant sails, that is, lower them.

**Dunnage.** A quantity of loose wood, &c. laid at the bottom of a ship, to keep the goods from being damaged.

**Dog-vane.** A small vane made with feathers and cork, and placed on the ship's quarter for the men at the cun and helm, to see the course of the wind by.



- Dog-watch.** The watches from four to six and from six to eight in the evening.
- Dispart** a piece of ordinance, is to find the difference of the diameters betwixt the breach and the mouth of the cannon.
- Dead-lights.** A kind of window-shutter for the windows in the stern of a the ship, used in very bad weather only.
- Dead-wind.** The wind right against the ship or blowing from the very point to which she wants to go.
- Dead-eyes.** Blocks of wood through which the lanyards of the shrouds are reeved.
- Driver.** A large sail set upon the mizen yards in light winds.
- Drive.** The ship drives, that is, her anchor comes through the ground.
- Down-haul.** The rope by which any sail is hauled down; as the jib down-haul.
- Ensign.** The flag worn at the stern of a ship.
- Engagement.** Action or fight.
- Entering-port.** A large port in the sides of three-deckers leading into the middle deck, to save the trouble of going up the ship's side to get on board.
- End for end.** A term used when a rope runs all out a block, and is unreeved; or in coming to an anchor, if the stoppers are not well put on, and the cable runs all out, it is said to have gone out end for end.
- Elbow, in the hawse.** Is when a ship being moored, has gone round upon the shifting of the tides, twice the wrong way, so as to lay the cables one over the other: having gone once wrong, she makes a cross in the hawse, and going three times wrong, she makes a round turn.
- Fathom.** A measure of six feet.
- Fack, or Fake.** One circle of any rope or cable quailed.
- Burl the sail.** Wrap it up close, and bind it upon the yard.
- Fish.** A large piece of wood. Fish the mast, apply a large piece of wood to it to strengthen it.
- Flag.** A general name for colours worn and used by ships of war.
- Fall off.** To fall to leeward, or a-stern.
- Foreward.** To the fore part of the ship.
- Forecastle.** The upper deck in the fore part of the ship.
- Freshen the Ballast.** Divide to separate it.
- Fid.** A square bar of wood or iron, with shoulders at one end; it is used to support the weight of the top-mast, when erected at the head of the lower-mast.
- Fid for splicing.** A large piece of wood of a conical figure, used to extend the strands and layers of cables in splicing.
- Forereach.** To shoot a-head, or go past another vessel.
- Fish-hook.** A large hook by which the anchor is received from under the hawse, and brought to the cat-head: and the tackle which is used for this purpose is called the fish-tackle.
- Gage of the ship.** Her depth of water, or what water she draws.
- Greave.** To burn off the filth from her bottom.
- Gripe of a ship.** That thin part of her which is under counter; and to which the stern-post joins. The ship gripes, that is, turns her head too much to the wind.
- Ground-tier.** That is, the tier of water casks which is lowest in the hold, and is among the shingle ballast.

Ground-

*Ground-tackle.* Is cables, anchors, grapnels, hawsers, &c.

*Grappling-iron.* A thing in the nature of an anchor, with four or six flukes to it.

*Gammon the bowsprit.* Secure it by turns of a strong rope passed round it, and into the catwater, to prevent it from having too much motion.

*Girt.* The ship is girt with her cables when she is too tight moored.

*Gun-Room.* A division of the lower-deck abaft, inclosed with net-work, for the use of the gunner and junior lieutenant, and in which their cabins stand.

*Gunnel.* The large timber that runs along upon the upper part of a ship's side.

*Gasket.* The rope which is passed round the sail to bind it to the yard when it is furled.

*Grummett.* A piece of rope laid into a circular form, and used for large boats oars instead of rowlocks, and also for many other purposes.

*Helm.* The instrument by which the ship is steered, and includes both the wheel and the tiller, as one general term.

*Helm's a lee.* That is, the tiller is quite down to leeward.

*Hard a weather.* Put the tiller quite up to windward.

*Haul.* Pull.

*Heave the capstan.* That is, turn it round with the bars.

*Heave handsomely.* Heave gently or leisurely.

*Heave hearty.* Heave strong and quick.

*Heave of the sea,* is the power that the swell of the sea has upon a ship in driving her out, or faster on, in her course, and for which allowance is made in the day's work.

*Hail.* To call to another ship.

*Halyards.* The ropes by which the sails are hoisted, as the topsail halyards, the jibb halyards, &c.

*Hawse holes.* The holes in the bows of the ship through which the cables pass. Fresher hawse, veer out more cable. Clap a service in the hawse, put somewhat round the cable at the hawse-hole to prevent its chafing. To clear hawse, is to untwist the cables when a ship is moored, and has got a foul hawse. Athwart hawse is to be across or before another ship's head.

*Hawser.* A small kind of cable.

*Hitch.* To make fast.

*Hoist.* To hawl, sway, or lift up.

*Heel,* or incline. She heels to port, that is, inclines or lays down upon her larboard or left side.

*Hold,* is the space between the lower deck and the bottom of a ship, and where her stores, &c. lie. To stow the hold, is to place the things in it.

*Hull of the ship.* The body of it. To lay a hull, is to lay to, with only a small sail in a gale of wind. To hull a vessel, is to fire a shot into any part of her hull.

*Hull-down,* is when a ship is so far off, that you can only see her masts.

*Hulk.* A ship without masts or rigging; also a vessel to remove masts into or out of ships by means of sheers, from whence they are called sheer hulks.

*Jeer blocks.* The blocks through which jeers are drove.

*Jeers.* The ropes by which the lower yards are suspended.

*Jelly boat.* A small boat.

*Jibb.*

**Jibb.** The foremost sail of a ship, set upon a boom which runs out from the bowsprit.

**Jibb-boom.** A spar that runs out upon the bowsprit.

**Junk.** Old cable, or old rope.

**Knot,** signifies a mile.

**Keel-haul.** To drag a person backwards and forwards under a ship's keel for certain offences. This practice is now laid aside in the British Navy, but is used by other powers.

**Knippers.** A large kind of plated rope, which being twisted round the messenger and cable in weighing, bind them together.

**Log,** and **Log-line,** by which the ship's path is measured, and her rate of going ascertained. **Log-board,** on which is marked the transactions of the ship, and from thence it is copied into the log-book every twelve hours.

**Larboard.** Left; as, larboard side, left side.

**Labours.** That is, the ship rolls and tumbles much.

**Landfall.** The discovery of the land.

**Land-locked.** Sheltered all round by the land, so that there is no view of the sea.

**Lash.** To bind.

**Lanch-bo,** signifies high enough, or a vast.

**Leeward.** With the wind, or towards the point to which the wind blows.

**Lae-shore,** is that upon or against which the wind blows.

**Luff,** or **Loofe,** signifies come nearer to the wind, or bring the ship's head up more to windward.

**Lift.** Incline. The ship has a-lift to port, that is, she heels to the larboard.

**Lanyards** of the shrouds, are the small ropes at the ends of them, by which they are hove taut, or tight.

**Lifts.** The ropes which come to the ends of the yards from the mast-heads, and by which the yards are tossed up and down.

**Mast.** The upright timbers or trees on which the yards and sails are set.

**Mizen-mast.** That mast which stands abaft, and from which its rigging and sails are named; as of the sails, mizen, mizen-top-sail, &c. and so also are the other sails, &c. named from the other masts.

**Moor,** is to secure a ship with two anchors.

**Mend the service.** Put on more service.

**Moufe.** A kind of ball or knob, wrought upon the collar of the stays.

**Muste.** To assemble.

**Messenger.** A small kind of cable, which being brought to the capstan, and the cable by which the ship rides made fast to it, it purchases the anchor.

**Nun-buoy.** The kind of buoys used by ships of war.

**Neap-tides.** The tides in the first and last quarter of the moon, and are not either so high, so low, or so rapid as spring tides. A ship is said to be benciped, when she has not water enough to take her off the ground, or over the bar, &c.

**Nothing off.** A term used by the man at the cun to the steersman, directing him not to go from the wind.

**Narrows.** A small passage between two lands.

**Offing.** To seaward from the land. A ship is in the offing, that is, she is to seaward, at a distance from the land. She stands for the offing, that is, towards the sea.

*Over-board*



**Over-board.** Out of the ship; as, he fell over-board, meaning, he fell out of, or from the ship.

**On board.** Within the ship; as, he is come on board.

**Oakum.** Old rope untwisted and pulled open.

**Orlop.** The deck on which the cables are stowed.

**Over-haul.** To clear away and disentangle any rope; also to come up with the chase; as, we overhaul her, that is, we gain ground of her.

**Pay the seams.** That is, to pour hot pitch and tar upon the seams after caulking.

**Purchase.** To purchase the anchor, is to loosen it out of the ground.

**Peck.** To ride a stay-peck, is when the cable and the fore-stay form a line. To ride a short peck, is when the cable is so much in as to destroy the line formed by the stay-peck. To ride with the yards a peck, is to have them topped up by contrary lifts, so as to represent a St. Andrew's cross.

**Ports.** The holes in the ship's sides from which the guns are fired.

**Pudding and dolphin.** A large and lesser pad made of ropes, and put round the masts under the lower yards.

**Pay out the cable.** That is shove it out at the hause holes.

**Pendant.** The long narrow flag worn at the mast head by all ships of the royal navy. Brace pendants are those ropes which secure the brace-blocks to the yard arms, and are always double, in case of one being shot away, the other may secure the yard in its proper position.

**Parcel a rope.** Is to put a quantity of old canvas round it before the service is put on.

**Parcel a seam.** Is to lay a narrow piece of canvas over it after it is caulked, before it is payed.

**Port.** Used for larboard, or the left side; also a harbour or haven.

**Points.** A number of plaited ropes made fast to the sails for the purpose of reefing.

**Quoil,** is a rope or cable laid up round, one fake over another.

**Quarters.** The respective stations of the officers and people in time of action. Quartering, distributing the men to different places. Quarter bill, the list of the ship's company, with their stations for action noticed.

**Quarter wind,** is when the wind blows in abaft the main shrouds.

**Reeve.** To reeve a rope, is to put it through a block, and to unreeve it is to take it out of the block.

**Rouse in the cable.** Haul it in, and make it taut, or tight.

**Reach of a river.** The distance between any two points of land that lie in a right line from each other.

**Ride at anchor,** is when a ship is held by her anchors, and is not driven by wind or tide. To ride athwart, is to ride with the ship's side to the tide. To ride hawse fallen, is when the water breaks into the hawse in a rough sea.

**Road.** A place near the land where ships may anchor, but which is not sheltered.

**Rounding.** Old ropes used to put in between the layers of the cable before it is sewed.

**Rattlines.** The small ropes fastened to the shrouds, by which the men go aloft.

**Rotter, or Rudder.** The machine by which the ship is steered.

**Rullock.** The nitch in a boat's side, in which the oars are used.

**Strike.** A term for yield or surrender, used to an enemy.

*Splice.*

- Splice.** To make two ends of ropes fast together by untwisting them, and then putting the strands of one piece with the strands of the other.
- Serve.** To wind something about a rope to prevent it from chafing or fretting. The service is the thing so wound about the rope.
- Scaze.** To bind or make fast.
- She sands, or sends.** When the ship's head or stern falls deep in the trough of the sea.
- Settle.** To lower; as settle the top-sail halyards, lower them.
- Sound.** To try the depth of water; also a deep bay.
- Sheer.** The sheer of the ship is the curve that is between the head and the stern, upon her side. The ship sheers about, that is, she goes in and out.
- Sheers,** are spars lashed together, and raised up for the purpose of getting out or in a mast.
- Scudd.** to go right before the wind; and going in this direction without any fail set is called spooning.
- Steeve.** Turning up. the bowsprit steeves too much, that is, it is too upright.
- Spring-tides,** are the tides at new and full moon, which flow highest, and ebb lowest.
- Spilling-lines,** are ropes contrived to keep the sails from being blown away when they are clewed up, in blowing weather.
- Starboard.** The right side.
- Spur-shoes,** are large pieces of timber which come up abaft the pump well.
- Spurling-line** is a line that goes round a small barrel, abaft the barrel of the wheel, and coming to the front beam of the poop deck, moves the tell-tale with the turning of the wheel, and keeps it always in such position, as to shew the position of the tiller.
- Spear of the pump.** The handle of an hand-pump.
- Steady.** A term used by the man at the cun to the steersman, when sailing before the wind, to keep her as she goes.
- Sway away.** Hoist.
- Stretch out.** A term used to men in a boat when they should pull strong.
- Swabb.** A kind of large mop made of junk to clean a ship's deck with.
- Sinnett.** A small platted rope, made from rope yarns.
- Stem.** She does not stem the tide; that is, she does not go through it, or cannot make head against it, for want of wind.
- Sued or Sewed.** When a ship is on shore, and the water leaves her, she is said to be sued; if the water leaves her two foot, she sues, or is sued two foot.
- Stays.** Large ropes coming from the mast heads down before the masts, to prevent them from springing, when the ship is fending deep.
- Spring-Stays,** are rather smaller than the stays, and placed above them, and intended to answer the purpose of the stay if it should be shot away, &c.
- Spring.** To break; as to spring a mast or yard, is to split or break it.
- Shank painter.** The rope by which the shank of the anchor is held up to the ship's side; it is made fast to a piece of iron chain, in which the shank of the anchor lodges.
- Stoppers.** Large kind of ropes, which being fastened to the cable in different places abaft the bits, are an additional security to the ship at anchor.
- Tack.** To go about.

- Trey sail.* A small sail used by cutters and brigs in blowing weather.
- Tell-tale.* An instrument which traverses upon an index in the front of the poop deck, to shew the position of the tiller.
- Traverse.* To go backwards and forwards.
- Tiller.* A large piece of wood, or beam, put into the head of the rudder, and by means of which the rudder is moved.
- Tort or taut,* signifies tight.
- Trice, trice up.* To haul up and fasten.
- Tarpaulin.* A cloth of canvas covered with tar and saw-dust, or some other composition, so as to make it water proof.
- Tide-gate.* A place where the tide runs strong.
- Tide it up.* To go with the tide against the wind.
- Tow.* To drag. The ship tows her boats, that is, drags or draws them after her.
- Truck.* A round piece of wood put upon the top of flag-staves, with sheaves, on each side for the halyards of the flags to reeve in.
- Tier* A row; as a tier of guns, a tier of casks, a tier of ships, &c.
- Trunnions* of a gun, are the arms or pieces of iron by which it hangs on the carriage.
- Tampions, or Tomkins.* The bung, or piece of wood, by which the mouth of the cannon is filled to keep out wet.
- Truck* of a gun carriage, is the wheel upon which it runs.
- Urrou.* The piece of wood by which the legs of the crow-foot are extended.
- Unfurl.* Cast loose the gasket of the sail.
- Unbend.* Cast off the sail from the yard.
- Under way.* When a ship is sailing, she is said to be under way.
- Veer.* Let out, as veer away the cable.
- Veer, or wear* the ship. That is, put her about with her head to leeward, the contrary way to tacking.
- Veer.* Shift. The wind veers, That is, it shifts or changes.
- Viol, or Voyol.* A block through which the messenger passes in weighing the anchor. A large messenger is called a viol.
- Vane.* A small kind of flag worn at each mast-head.
- Wake.* The path or track impressed on the water by the ship's passing through it, leaving a smoothness in the sea behind it. A ship is said to come into the wake of another when she follows her in the same track, and is chiefly done in bringing ships to, or in forming the line of battle.
- Weather.* To weather any thing, is to go to windward of it.
- Wales,* are strong timbers that go round a ship a little above her water line.
- Water-line.* The line made by the water's edge when a ship has her full proportion of stores, &c. on board.
- Warp.* To warp a ship is to draw her against the wind, &c. by means of anchors and hawfers carried out.
- Warp.* A hawser, or small cablet.
- Would.* To would is to bind round with ropes, as the mast is woulded.
- Weigh.* To haul up, as weigh the anchor.
- Yaws.* The ship yaws, that is, goes in and out, not steady.
- Yards.* The timbers upon which the sails are spread.



*The following Questions and Answers are recommended to the Perusal of young Gentlemen belonging to the Sea, in order to refresh their Memories, previous to that Examination which they must pass through, before they are appointed to a Commission in the Royal Navy, or an Officer in the East-India Service; as it is probable similar ones may be asked, by those appointed to examine them, at the Navy Office and the East-India House.*

*Quest.* **H**OW do you find the golden number?

*A.* I add one to the given year, and divide the sum by 19, the remainder will be the golden number.

*Q.* How do you find the epact for any year?

*A.* By dividing the given year by 19, and multiplying the remainder by 11, the product will be the epact, if it does not exceed 30; but if it does, I subtract 30 from it as often as I can, and the remainder will be the epact.

*Q.* How do you find the moon's age?

*A.* To the epact I add the day of the month, and the number of the month; their sum will be the moon's age, if it does not exceed 30; but if it does, I subtract 30 from it as often as I can, and the remainder will be her age.

*Q.* How do you find the moon's southing, or the time of her coming to the meridian?

*A.* I multiply the moon's age by 48, and divide the product by 60; the quotient will be the hours, and the remainder the minutes when she is on the meridian past noon: Or, I may multiply the moon's age by 4, and divide the product by 5, the quotient will be the hours and the remainder multiplied by 12 will be the minutes when she souths, or is on the meridian, in the afternoon: But if this time should exceed 12, I subtract 12 from it, and the remainder will be the time of her southing in the morning.

*Q.* How do you find the time of high water at any place?

*A.* To the moon's southing on the given day I add the time of high-water, full and change, at the given place, and the sum will be the time of high water there in the afternoon: But if this time should exceed 12, I subtract 12 from it, and the remainder will be the time of high water in the morning; and if it exceeds 24 I subtract 24 from it, and the remainder will be the time of high water in the afternoon\*.

*Q.* Suppose that you go into an harbour, and find by your watch that it is high water at any hour of the day; by what means do you find the times when it is high water on full and change days in that place?

*A.* I find the time of the moon's southing on that day, and subtract it from the time of high water at the given place, if I can, and that will be the time of high water. If I cannot, I add 12 to it, and then subtract the above time; the remainder will be the time of high water at the given place, on full and change days.

*Q.* How do you find the zenith distance of any object?

*A.* By correcting the altitude for the dip, refraction and semidiameter, and then subtracting it from 90°, the remainder will be the zenith distance, which will be either north or south, according as the object bears of me.

\* The time of high water is found more correct by the tables, see page 141.

*Q.* Suppose

Q. Suppose the zenith distance  $10^{\circ}$  north, and the declination  $20^{\circ}$  north, what latitude are you in, and of what name?

A. Ten degrees north.

Q. The sun is in your zenith, what latitude are you in?

A. The same as the declination is, whether north or south.

Q. Your zenith distance is  $20^{\circ}$  north, and your declination is  $20^{\circ}$  north, what latitude are you in?

A. Upon the equator, and consequently in no latitude.

Q. Suppose that your zenith distance is  $50^{\circ}$  south, and the declination  $10^{\circ}$  north, what latitude are you in?

A. Sixty degrees north.

Q. Suppose your zenith distance be  $45^{\circ}$  north, and the declination  $15^{\circ}$  south, what latitude are you in?

A. Sixty degrees south.

Q. Suppose your zenith distance is  $45^{\circ}$  north, and the declination  $15^{\circ}$  north, what latitude are you in?

A. Thirty degrees south.

Q. What do you mean by the word amplitude?

A. The true amplitude is the number of degrees that the sun, moon or stars, rise and set, to the northward or southward of the true east or west. The magnetic amplitude is the number of degrees they rise or set to the northward or southward of the east or west point of the compass.

Q. How do you find the true amplitude?

A. As the co-sine of the latitude : is to the radius :: so is the sine of the sun or star's declination : to the sine of the true amplitude. Or if the secant of the latitude be added to the sine of the sun or star's declination, the sum (rejecting 10 in the index) will be the log. sine of the true amplitude.

Q. But supposing the evening or morning proves cloudy, and you cannot see the sun or a star, how will you find the variation of the compass?

A. By an azimuth.

Q. What do you mean by an azimuth?

A. The true azimuth is the distance of the sun or star from the true north or south at every degree and minute of altitude.

The magnetic azimuth is their distance, at each degree and minute of altitude, from the north or south point of the compass.

Q. How do you find the true azimuth?

A. By adding the complement of the latitude, the complement of the altitude, and the sun or star's polar distance into one sum; from half this sum I subtract the polar distance, noting the half sum and the remainder: Then, to the arithmetical complement of the co-sine of the latitude, I add the arithmetical complement of the co-sine of the altitude; the log. sines of the half sum and the remainder; half the sum these four logarithms will give the co-sine of half the true azimuth, which being doubled is the true azimuth, reckoned from the north in north latitude, and from the south in south latitude.

Or it may be found thus:

To the log. co-secants of the co. latitude and altitude, add the log. sines of the half sum and the remainder; half the sum of these four logarithms (rejecting 20 in the index) will be the log. co-sine of half the true azimuth, as before.

Q. You have given the true amplitude or azimuth by calculation, and the magnetic amplitude or azimuth by observation; how do you find the variation?

*A.* By placing both the amplitudes or azimuth before me, then, if the true amplitude or azimuth be to the right hand of the magnetic, or observed, the variation is east, but if it be to the left hand, it is west.

*Q.* You have the latitude and longitude the ship is in, consequently her place, how do you shape her course, or in other words, find her course and distance to any other place, whose latitude and longitude is known?

*A.* It may be found briefly by the tables of difference of latitude and departure, but by logarithms I will say,

As the meridional difference of latitude : is to radius :: so is the difference of longitude : to the tangent of the course. And,

As the co-sine of the course : is to the proper difference of latitude :: so is radius to the distance.

*Q.* You have the difference of latitude and departure made good in the 24 hours, how do you find the course and distance, and the ship's place, by logarithms?

*A.* As the difference of latitude : is to radius :: so is the departure : to the tangent of the course. And,

As the co-sine of the course : is to the difference of latitude :: so is radius : to the distance made good in the 24 hours.

Having the latitude and longitude left, and the difference of latitude, I find the latitude in, and the meridional difference of latitude; I then say,

As the co-sine of the course : is to the meridional difference of latitude :: so is the sine of the course : to the difference of longitude. Or, as the proper difference of latitude : is to the departure :: so is the meridional difference of latitude : to the difference of longitude. Having the longitude left, and the difference, the longitude in is found by addition or subtraction, as the case requires.

*Q.* You have now the ship's place by calculation, how do you find it on a Mercator's Chart?

*A.* By laying a ruler across the Chart on the ship's latitude, and taking her longitude in my compasses, and setting one point on the meridian, by the side of the ruler, I turn the other east or west, according as the longitude is, (by the side of the ruler) and it will point out the ship's place.

*Q.* You have now the ship's place, how do you find her bearing and distance to any other known place?

*A.* By laying a ruler over the point where the ship is, and the given place, and with the compasses I take the nearest distance between the ruler and the center of some compass on the Chart; and slide the compasses along the ruler, (keeping both points perpendicular to it) the farthest point from the ruler will shew the course, or bearing between the ship and place. Again,

I take the distance between the ship and place in the compasses, and then lay one point on the meridian as much below the ship's place, as the other is above the given place; that distance, reckoned in degrees, leagues or miles on the meridian, according as it is divided, will be the distance.

*Q.* You are ordered to a ship, she is lying in dock; prepare to take her out of dock.

*A.* I would take on board what kentledge was necessary, stream anchor and cable, kedge anchor, hawser and tow-line, with some spare ropes for guys, to keep her fair for the dock gates; buoy and buoy-ropes, for stream and kedge.

*Q.* When your ship is out of dock, what is first to be done?

*A.* I would

Circumference  
in Inches.





will take it up the first quarter flood, get the cat and fish to pass for the best bower, stretch along the fish tackle; quarter-masters down in the tier, and stand by to veer away the small bower-cable; ship the capstan-bars, pin and swift them; clap on the stoppers before the bits, and bring to the messenger. At the same time unbit the best bower, rowle aft the slack of the cable; heave taught, take off the stoppers, hold on the messenger, and heave away; veer away the small bower-cable; clap on the nippers: Thick and dry for weighing, heave chearly; the anchor's away, keep fast the small bower cable; quarter-master take hold of the helm; look out for the anchor; the anchor is in sight; heave and paul the capstan; hook the cat; haul taught, and take a turn; surge the messenger round the capstan; take off the nippers; out cable; cable enough; haul cat; belay the catfall; pass the stoppers; hook the fish; try fish by hand; haul away the fish; belay the fish tackle-fall; pass the shank painter; bowse to the stock-tackle; belay the shank painter; make fast the stopper and stock lashing; come up cat and fish; unhook both; haul the buoy in; then shift the messenger for the small bower and bring to, clap on the stoppers before the bits and unbit the cable; rowse aft the slack of the cable; man the capstan; hold on the messenger; fore-castle-men; rig out the davit for the small bower; when the anchor is a-peak, send the top men to loose the sails; man the yards; stretch along the top sail sheets; let go the top sail; reef tackles, bunt-lines and clue-lines; foot the sails out of the top; haul home the top-sail sheets; stretch along the top-sail halyards and man them; quarter-master and boatswain's mates attend to the braces; hoist away the top-sails; belay the halyards; trim the sails; heave up the anchor; stow it as before, and haul the bouy in.

Q. How would you unmoor with the wind S. E. or S. ?

A. Veer on the best bower-cable, and take the small bower anchor up first; and proceed as before, then to heave in to the short service on the best bower, &c. If the anchor has great hold and afraid of stranding the messenger, clear away the main capstan and lash a block or purchase blocks, on the cable, and one to the main-mast; or one to the two ports abreast of the main-mast; reeve a hawser through them, and heave on both capstans together.

Q. Suppose you are close upon a wind, in moderate weather, with all your sails set, how will you tack the ship?

A. I would hand down the lee-bow-lines, stretch along the weather-braces, the weather sheets and lee-tacks; then put the helm a lee, let go the fore-sheet, lee fore-top-sail, brace and fore-top-bow-line, jib, and stay-sail-sheets: and haul them taught. When the fore-top-sail touches, brace to and help her; when aback brace up and help her; when the wind is out of the after-sails, raise tacks and sheets; shift the stay-sail-tacks, and haul over the stay-sail-sheets; cant sprit-sail-yard, when the wind is rather  $\frac{1}{2}$  a point on the bow if sure of coming about, haul the main-sail. N. B. One watch of the top-men on the quarter-deck and fore-castle to set up the weather-breast-back-stays: If she has stern-way, shift the helm and square the sprit-sail-yard; haul on board the main tack and aft the main sheet. Brace up the main yard when the after-sails are full; haul off all; and haul on board the fore-tack; keep in the weather-braces forward, and let her come to, then brace up; haul aft the fore sheet, jib and stay-sail-sheets; set the back stays when head to the wind up, and haul

haul the bow-lines; then haul taught the weather-braces, lee-tacks and weather-sheets; have the braces let go at once; when the word is given to haul main-sail, (all the hands on the braces should keep hauling taught in for the run), the yards will swing of themselves.

Q. How would you tack a ship under her three top-sails?

A. I would put the helm a lee, ease off the fore-top-sail brace, keep fast the fore-top bow-line; when the fore top-sail touches, brace to and help her; when the wind is a head, haul the main top-sail and shift the helm; then brace up the main-yard, and haul the main-top bow-line; when the after-sails are full, let go and haul; keep in the weather-braces forward, and when she comes to brace sharp up, haul the main and fore-top bow-lines, and haul taught the weather-braces.

Q. How do you veer, or, wear a ship with all her sails set?

A. I would haul the mizen up, and the mizen-stay-sail down, or trail it up, hard a weather the helm, shiver the mizen-top-sail, let go the main and main-top bow-lines, ease off the main-sheet, the lee-main-brace, and round in the weather-brace. When the wind is abaft the beam, raise the main-tack; when the wind is aft, square the head-yards, and get the other tacks on board; haul aft the sheets, shift the jib and stay-sail sheets over the stays, and as she comes to, haul the mizen out; hoist the mizen stay-sail, and haul aft the sheet; brace the head-yards up, haul the bow-lines, and trim all sharp. It a fresh wind, and should be proper to shorten sail, in top-gallant-sails, down jib and stay-sails, take one or two reefs in the top-sails.

Q. It blows hard, would have you proceed to close reef the top-sails?

A. I would let run the halyards, and haul the yards close down by the clue-lines and down-haul tackles; if the wind is large, man the clue-lines and bunt-lines, let go the sheets, and clue them close up; haul in the weather-brace, and spill the sail as much as possible; then haul out the reef tackles, send men up and haul out the weather earing first, then the lee one, and reef away, hauling the other reefs up before the yard: If the ship is upon a wind when the top-sail-yard is down, let go the bow-line. It is mostly the way to man the clue-lines and the bunt-lines, to ease off the lee-sheet and clue it up; then man the weather-brace, let go the lee-brace, ease off the weather-sheet and clue it up, hauling in the weather-brace and bunt-lines at the same time; when the sail is spilled, haul out the reef-tackles, and reef as before. But to keep the sail from splitting or shaking (especially if it be wet) it is the best way to man the clue-lines, bunt-lines and weather-brace, let go the lee-brace, ease off the weather sheet, hauling up the clue-line, and in with the weather-brace at the same time; when in enough, ease off the lee-sheet, clue up, &c. N. B. To set a top-sail on a wind when it blows strong, always haul the lee sheet home first, then the weather one, &c. &c. as before.

Q. It blows harder, you must take in your top-sails?

A. I would take in the fore and mizen top-sails first, because it will ease the ship forward, (for when it blows hard we generally have a head sea, and she keeps to the better) let go the fore-top bow-line, lower away the halyards, man the clue-lines and bunt-lines, clue close up, and haul out the reef-tackles, haul in the weather-brace, steady the lee-brace, haul taught the top-sail halyards; send the people up to hand the sail, and when up, before they go on the yard, I'll clap the rolling tackle on to steady the (all the top-sails should be taken in the same way) after that, if squally, take in the main-top-sail, and then the ship is under her courses.

Q. How



Q. How would you veer a ship under her courses?

A. I would haul the mizen and main-sail up, and down with the mizen-stay-sail, square the after-yards, hard a weather the helm, man the weather fore-brace, and ease off the lee-brace and fore bow-line; ease off the fore-tack, and stand by to haul on board the other; keep her large if room, until I get the tack on board and belay it; then luff up to the wind, haul aft the fore-sheet and brace up the fore-yard, set the after-sails, aboard main tack, aft the main-sheet, brace all up, and haul the bow-lines; when my sails are trimmed, shift the rolling tackles on the top-sail-yards.

Q. Suppose you are lying to in a hard gale of wind, under a reef main-sail, you want the ship's head on the other tack; how will you veer in a great sea?

A. I will watch her falling off, and put the helm a-weather, when she does, ease off the main-sheet; if that will not do, I'll man the fore shrouds, and get tarpaulins and hammocks or spare canvas up, and spread it: If that will not do, I will haul aft the main-sheet, and put the helm a lee, then send hands out to the sprit-sail yard with hammocks and gaskets to stop the sprit-sail, (called balancing) within the lee clue-line; block and loose the lee yard-arm, then haul aft the sheet, clap the helm hard a-weather, ease off the main-sheet, round in the weather-brace, gather aft the other sheet, haul the main tack on board; when she is before the wind, square the sprit-sail yard, clue the sail up and furl it; ease the helm down a-lee, brace the yards up, haul the main-sheet aft, bowse the bow-line up, lash the helm three parts a-lee and she will lay to as before.

Q. Suppose she will not veer after all you have done?

A. I will loose the goose wings of the fore-sail; if that will not do, set the fore-sail and veer her as under her courses, or haul the main-sail up; if by hauling the main-sail up and furling it she does not veer, lower down the mizen-yard; if that will not do, lower down the cross-jack-yard and mizen-top-mast; if that will not do, cut away the mizen-mast.

Q. How do you cast a ship, when intending to get under way?

A. If I am to cast her to starboard, I would haul in my larboard braces forward, and let my after-yards lay square; I may hoist the fore top-mast stay-sail, and keep the sheet to windward to help her; if I am to cast her to port, I would haul in the contrary braces, when cast, fill the head-sails and brace up as circumstances require. N. B. If a ship is wind rode, as soon as the anchor is right up and down, put the helm the way you would have her cast, setting in the same braces abaft, and the contrary forward; but if she is tide rode, the helm must be put the contrary way to which you would have her cast, and set in the braces forward; which ever way the helm is, the braces abaft must be the contrary.

Q. It blows hard, and you split your top-sail?

A. I would let go the bow-line, haul in the weather-brace, and lower away the halyards, clue up the lee-sheet, haul up the bunt-lines, start the weather-sheet, belay the clue-lines and bunt-lines, unbend the sail, bend another; then either furl or set it, as circumstances require.

Q. You are lying to in a hard gale of wind, and split your main-sail?

A. I will haul it up carefully, unbend the sail, and bend another, get on board the main tack, and haul aft the sheet; when the sail is set, get a tackle on the weather leach to secure the tack, and a preventer sheet; but in small ships they get the lee tack aft for a preventer sheet.

Q. Suppose you are on a wind, and let the ship come up in the wind, and are all aback, what will you do?

A. I will

*A.* I will box her off, and suppose she will not box off, I will haul the mizen up, let go the main and main-top bow-lines, the lee main and main-top-sail braces, and lay all square abaft, put the helm to leeward, if she has stee'n-way, when the wind is abaft the beam shift the helm; and, as she gets head-way, haul in a little of the after braces, haul the mizen out, brace up sharp abaft, and haul the bow-lines; and then I am on the same tack as before.

*Q.* Suppose you are on a wind, close upon the land, and standing on must run on shore, and you can clear the land on the other tack; but it blows hard, and a head swell, that she will not stay; and should you veer you would be on shore, how would you get upon the other tack?

*A.* I would club haul her; this is done by putting the helm a-lee, and letting go the lee anchor, and bringing her up head to wind; then cut the cable and haul about the after-sails; and when they are full, brace about the head-sails, haul on board the fore-tack, and brace up the other way.

*Q.* If by accident your ship is brought by the lee, what would you do?

*A.* When a ship is brought by the lee, it is commonly occasioned by a large sea, and by the neglect of the helm's-man. When the wind is two or three points on the quarter, the ship taking a lurch, brings the wind on the other side, and lays the sails all dead to the mast; as the yards are braced up, she then having little way, and the helm being of little service, I would therefore brace about the head-sails the other way, and keep the main-top-sail shivering; when she gathers way, and brings the wind aft again, raise the fore tack and square the head-sails; trim the sails as they were before, and bring her to her course again. *N.B.* It is dangerous to bring a ship by the lee in a gale of wind, for she lying entirely against the sea, her sails can be of little service till they are braced about.

*Q.* Coming into soundings from a long voyage, I would have you prepare for going into port and anchoring.

*A.* I'll order the cables to be bent; thus, get their ends up, reeve, hawse, and ring ropes to haul them out, the fore-castle-men to clinch them, and quarter-masters to clap the bends on, reeve the runners and tackles, unfurl the anchors, bend the buoys and buoy-ropes, single the stoppers and shank-painters, bit the bower-cables with a long range, have the dog-stoppers to pass, see the tiers clear, have hand-leads and lines in the chains, send down the top-ropes, reeve the top-tackle-falls, unslung the lower yards, when the cables are bent, &c. clap the hawse bucklers on.

*Q.* You are off the Eddystone, the wind at S. W. in a hard gale, under a reef fore-sail, and you must anchor in Plymouth sound, how will you bring up for the safety of the ship, and with what anchor?

*A.* To give myself time for anchoring, I will haul my fore-sail up, get the sheet anchor over the side, and bit the cable to the after-bits with a range, get down top-gallant masts and sprit-sail yard, in fore and aft, unfurl the top-masts, and stretch along the jeers, clap the wing stopper on the second cable of the best bower; being all clear, I'll set my fore-sail and steer in for the Sound, and when I am near the place I intend to anchor in, I'll man the fore clue garnets, and stand by to lower the yards and top-mast, being ready, lower away, haul the fore-sail close up, and furl it a Portland, clap rolling tackles on the lower yards, and heel ropes on the top-masts; having the marks on to anchor, stream the best bower buoy, and see that it goes clear of the ship, and when I intend to bring up, put the helm down, and haul the mizen out, then let go the anchor and veer away at least one and a half cable before I check her; should the

ship drive with two cables out, on the best bower, stream the small bower buoy and let go the anchor, which will allow me to veer a cable on the small bower, this will bring her up if it blows ever so hard, and I have still the sheet-anchor to stand by; when I have brought up, and double-bitted and stopped the cables, I'll get the top-sail yards fore and aft in the tops, and make the ship as snug as possible; as soon as the gale is over, get the anchors up and moor properly. The best method is to unbend the small bower buoy rope from the anchor, it being liable to get foul of the best bower cable, by the buoy going over and over again of the said cable, which has been often the case.

*N. B.* In coming from the westward with a hard gale of wind, and bound into the Downs, take the same method.

Q. Suppose you are on a lee shore, and had neither room to veer or stay, nor any anchoring ground, how would you put the ship's head round the other way?

A. I would put my helm hard a-lee, when she comes head to wind raise the fore and main tacks directly, make a run with my weather braces and lay all aback at once, then haul forward my lee-tacks and bowlines as far as I can, that the ship may fall round on her heel, and when the main-sail begins to shiver, I would haul it up, fill my head-sails, and shift the helm hard a-weather; when the wind comes on the other quarter, haul on board the main-tack, and bring her close to the wind.

Q. Suppose you were on a lee shore, and could clear the danger on the other tack, although not room to veer and a sea on she will not stay, and you had good anchoring ground, what would you do?

A. When I saw the danger I would take a good hawser, and lead it out of one of the quarter ports, and bend it to the anchor to leeward; the other part I would bring to the capstan, ship the bars, and when I clap the helm a-lee, and as soon as the wind is out of the main-sail, haul it up, let go the anchor, and heave on the spring to cast her, because the cable should not check her. When she comes head to wind, brace about the main-yard, haul on board the tack, and cut away the cable and spring; when the main-sail fills, set the fore-sail, haul on board the tack, and trim her to the wind.

Q. Suppose it blows hard, you cannot carry your courses, night coming on, and it is likely to blow harder, what will you do?

A. I would haul the fore-sail up and furl it, balance the mizen, haul it out to keep her to, then haul up the weather main-clue-garnet and bunt-line, then the lee clue-garnet-bunt-lines and leach-lines, square the yards, and get strops round the mast above the booms to hook the yard tackles to for rolling tackles, then reef the sail, when reefed, haul on board the tack, get aft the sheet, handsomely, tend the braces, bowse up the bow-line and haul up the mizen.

Q. You are just abreast of Portland, the wind has taken you aback; you have all sails set, and you have no time to take them in, for you will be on shore or in the race presently, how will you proceed?

A. If she has head-way, I will put the helm a-port, let go the fore-sheet and larboard braces; as soon as the after-sails shiver, haul down all the studding-sails; if it blows fresh, take in top-gallant-sails, brace up the after-yards; when full, brace up forward and haul on board the fore-tack, trim all sharp, haul taut the weather-braces and haul the bow-lines, the bow-lines first, then the weather-braces.

Q. Suppose



Q. Suppose you are turning over the Flats with your top-sails and fore-sail, you endeavour to put about, but she will not stay, there is a sand a-head within a cable's length of you, what will you do?

A. I will heave all aback, and when she has stern-way shift the helm; when she has paid well off, brace about the head-sails and shiver the after-sails; then she will veer round and stand off.

Q. You are in a gale of wind, and split your fore course, what will you do?

A. I'll man the weather fore clue-garnet, bunt-lines and leach-lines, ease off the fore-tack, and when clued up, man the lee-clue-garnet and haul it close up; then let go the lee-brace, haul taut the lifts and braces, send hands to unbend the sail; when another, is bent, and I want to set it, I will haul on board the fore-tack, and haul aft the fore-sheet, brace the yard up and haul the bow-line.

Q. It blows hard, and you want to reef your courses, how would you proceed?

A. I will clear away the top-sail sheets and lifts, man the down haul tackles, lower away the jeers, let go the bow-lines, and clue the sails up round the weather-braces, haul taut the lifts, braces, and rolling tackles; then send hands up to reef the sails; when I want to set them, I will proceed with the sails as before.

Q. Suppose it blows hard at S. W. and you are drove from your anchors in the Downs, what would you do?

A. I would steer for the gull stream, which I shall know by having the upper Light on the South Foreland to bear S. W. by S. then steer away between the N. E. and N. E. by N. which will carry me between the Brake and the Goodwin Sands, keeping to the Goodwin in nine or ten fathom, and to the Brake in seven or six.

Q. You are standing on a wind with all your sails set; your enemy is in sight, standing towards you, how do you clear your ship for action?

A. I will turn all hands up to clear ship, up all hammocks, the quarter-masters to stow them in the netting, and on the gang-way; get the top-mens hammocks up in the top; down all chests in the hold; quarter-masters stow them; take in all the small sails; sling the lower yards with top-chains, get the puddings and dolphins up; then sling the top-sail yards half-mast or close up; stop the top-sail sheets, stoppers on the jeers, or else rack them; gunners get the match-tubs between every two guns, matches, powder-horns, crows, and handspikes sufficient for every gun; all hands to quarters, keep silence and mind the word of command, fire not a gun until the word of command is given; mind you do not fire a shot in vain. Now I have all the three masts in one, fire!

Q. Suppose you are in chase of an enemy's ship of war, upon a wind, with all your sails set; she is right ahead, on which side will you engage her?

A. I will engage her to leeward, by reason she cannot put away before the wind, and if there is any thing of a sea, she may not be able to fight her lower tier of guns. If light breezes and hot weather, it would be better to engage to windward, to let them receive the smoak and heat of the fire.

Q. You are chasing from the wind, and carry away your main-top-mast how will you proceed?

A. I would haul up the main-sail and send hands up into the top with a rope or hawser, to clap on that part of the mast that hangs down, then cut the lanyards of the main top-mast shrouds, and lower away, cast off the hawser, reeve it to send the stump down, clear away the rigging, unslung

the main yard, get the foretackle on it and bowse forward the yard, then lower the stump upon deck, and get the spare top-mast ready for the cross-trees; clap the hawser on and sway it up high enough for the rigging.

Q. You are lying to in a hard gale of wind under your main course, you carry away your main-mast, how will you proceed to clear the wreck?

A. I will clap my helm a-weather, brace my fore and fore-top-fail yards full, then call all hands to get pole-axes, &c. to clear away the rigging.

Q. Why will you put the ship before the wind?

A. Because the mast will go a-stern clear of the rudder, and prevent its damaging the ship.

Q. You are going large and see a ship in the wind's eye, how will you proceed to chase her?

A. I will turn all hands up, get my tacks on board, brace up my yards and haul aft the sheets; haul the bow-lines, set the jib and stay-fails, keep her full, and by making short boards and turn directly to windward, which will prevent her putting away large.

Q. Suppose you were to carry away your bowsprit, what would you do?

A. I would immediately veer ship, and keep her before the wind; and then, for the security of the fore-mast, I would carry forward the fore-runners and tackles, and bouse them well taut, till I can get a hawser or sufficient rope, and clinch it round the mast-head, and secure it to the bits of the fore-castle or the cat-heads; then take the best spar I have, and make a jury bowsprit of it.

Q. Having a fair wind, how will you set your fore-top-mast studding-fail, on the larboard side?

A. First haul taut the truss tackles, and bowse the fore yard close to; then haul taut the larboard fore-lift, and starboard fore-top-fail clue-line, on board his majesty's ships the top burtons are on the top-fail yards to keep them square when studding fails are set, (the top-fails, lifts and clue-lines not thought of) the fore-top men down on the foreyard, and rig out the larboard studding-fail boom, first sending down the studding-fail tack and outer balyards up to the fore-top-fail larboard yard-arm; and reef the halyards, send them down and bend them; the tack being bent and all ready, man the halyards and hoist away, haul out the tack, &c. If the wind is on the beam or quartering, set it abaft the top-fail; if right aft before the top-fail, (which is done by a man standing on the fore yard-arm, with the leach of the studding-fail in his hands).

Q. Suppose you are in an engagement, and your main-top-mast stay is shot away, how will you secure your mast?

A. I will send my shifting back-stay forward by the main-top-mast stay-fail halyards, and reef it through a block abaft the fore-mast head, bowse it taut, and that will secure the mast.

Q. Your ship comes to against her helm, what will you do?

A. I will haul my mizen up, and shiver the after-fails.

Q. She comes to yet, if she stays she will be on board some other ship?

A. I'll let go the lee-fore and fore-top-fail braces, raise the fore tack and let go the bow-lines, haul in the weather-braces and box her off.

Q. How do you splice your cables?

A. I will put the whole strands of the best or small bower cables twice each way, and point each strand with a tail of three fathoms each; then seize them with quarter and end seizing, to make them lie snug, which is the readiest way for clearing the hawse. They being soon spliced and unspliced when pointed.

Q. How

2. How would you mark the lead-line ?

A. Black leather at 2 and 3 fathoms, white at 5, red at 7, black at 10, white at 13, (some seamen use black at 10 and 13) white at 15 as at 5, red at 17 as at 7, two knots at 20 fathoms, and so on, an additional knot at every 10 fathoms, with a single knot between each 10 fathoms to mark the line at every 5 fathoms.

2. You are sent down in the dark for a top-sail, how do you know a main-sail from a fore-sail, or a main-top-sail from a fore-top-sail ?

A. If it has three bow-line cringles it is a main-sail, if it has but two, it is a fore-sail ; if it is marled abaft the foot-rope, it is a main-sail, if before, it is a fore-sail : If a main-top-sail, it has four bow-line cringles, if a fore-top-sail but three; all top-sails are marled to the rope, because the foot-rope is served.

2. The sheers are alongside, how do you get them in ?

A. Par-buckle them in with their heads aft on the poop, and get the fore and main-runners on them for guys; lash on two fourfold blocks, reeve the masting-falls, get girt-lines on the head of the sheers to steady the mast-head, put heel lashings on the sheers, with good oak planks under them, to transport them forward on; lash one of the fourfold blocks forward to the stem, and bring the fall to the capstan; heave the sheers high enough: when done, I'll take forward two runners and tackles to assist the sheers, take the mizen-mast first in, then raise the sheers erect, take in the main-mast, bowse the heels of the sheers forward, and keep them upright to take in the fore-mast.

2. How do you rig a lower mast ?

A. I will lash on the girt-line-blocks, put on the bolsters, parcel and tar them, put over the runner and tackle-pendants, then the foremost of the starboard-shrouds, then the larboard, and so on; then the stay and spring-stay, seize in the dead eyes for the shrouds, and the harts for the stay, reeve the lanyards, set up the rigging, get the top over head, and bolt it, rattle down the shrouds, and seize on the cat-harpin-legs, hook the futtock shrouds, and hitch them, seize down the ends, lash the hanging jeer-blocks under the top, with the strops under the stays, lead up and lash to the mast-head, get the cap into the top for the head of the top-mast, and lash the blocks on for the main-lifts.

2. How do you get a-top and cap over ?

A. Make fast a girt-line-block, on each side of the mast-head, reeve the girt-lines and pass them under the top, and make them fast to the after-part of the top, stop them to the bolt-holes in the middle and fore-part of the top, then sway away; when high enough, cut the upper stops having a guy on the after-part of the top-brim, and the top will fall over the mast-head, then lower away, and put it in its birth, haul upon the guy and bolt it, lay the cap steady over the trussel-trees for the top-mast-head, to receive it; when the top-mast-head is through it, lash the cap to the top-mast-head, sway away the top-mast till high enough, then place the cap on the mast-head, and drive it down.

2. How do you rig a main-top-mast ?

A. I will tar the mast-head, get the cross-trees over, fix the bolsters and parcel them, put over burton-pendants, then the shrouds, breast-back-stay, proper and spring-stay, and cap, sway up the mast and fid it, seize in the dead eyes, stay the mast, set up the shrouds, rattle them down, lash the bollock-blocks to the mast-head.

2. How do you rig a top-gallant-mast ?

A. I will



*A.* I will send down the top-rope, reeve it through the sheave-hole, and make it fast round the hounds of the mast, and standing part of the rope, leaving enough end to make fast to the cap, which done, sway away, when the head is through the cap, make fast the spare end or standing part of the top-rope to the cap, cut the seizing, clap on the grommet, then the shrouds, back-stays and stay, sway up the mast, fid it, and set the rigging up.

*Q.* How do you rig a bowsprit?

*A.* I will lash the collar fore-stay for the bob-stays and bowsprit shrouds, then the collar for the spring-stays, then the block for the top-mast-stay, fix the man-rope, gammon the bowsprit, and set bob-stays and shrouds up.

*Q.* How do you rig a jib-boom?

*A.* I will put over the traveller, horses, and guys, the top-gallant stay, block, and lash on the blocks for the the top-gallant-bowline, and jibb-down-haul-block to the traveller.

*Q.* How do you rig a lower-yard?

*A.* I will get athwart the gunwale, lash the jeers, quarter clue-garnets, bunt-lines, leach lines and slab-line-blocks, then put over the yard-arms the horses brace-pendants, the yard-tackle-pendants, then the top-sail sheet, and lift-blocks, reeve the jeers, braces, lifts, and yard-tackle falls, truss parcels, sway the yard up, and haul all taut.

*Q.* How do you rig a fore top-sail yard?

*A.* I will reeve a hawser for a top-rope, through the bollock block, and send it down, and having put over the horses, make the top-rope fast to the middle of the yard, stopping it to the yard arm, sway it up above the top, put over the brace-pendants and lift-blocks, reeve the lifts and braces, cut the yard-arm-seizing, and cross the yard, lash the tye, bunt-line and clue-line-blocks, reeve the tye and halyards, sway it up above the cap, and parcel it, reeve the clue-lines, bunt-lines and reef-tackles.

*Q.* How do you rig a top-gallant-yard?

*A.* I will seize the clue-line-blocks on, put the horses over the yard-arms, sway it up on the cap, and rigg the yard-arms, by putting on the brace-pendants and lifts, then cross the yard and parcel it.

*Q.* You have lost your rudder at sea, what method will you take to steer the ship?

*A.* I will take a large spar, or part of a top-mast, and cut it flat in the form of a stern-post, bore holes at proper distances in that part which is to be the fore-part of the preventer, or additional stern-post, then take the thickest plank I have on board, and make it as near as I can, into the form of a rudder, bore holes at proper distances in the fore-part of it, and in the after-part of the preventer stern-post to correspond with each other; and reeve rope-grammots through those holes in the rudder and after-part of the stern-post for the rudder to play upon.

Through the preventer stern-post reeve guys, and at the fore-part of them fix tackles, and then put the machine over board; when I get it in proper position or in a line with the ship's stern-post, lash the upper part of the preventer-post to the upper part of the ship's stern-post, then hook tackles at or near the main-chains, and bowse taut on the guys to confine it to the lower-part of the preventer stern-post;—having holes bored through the preventer and proper stern-post, I will run an iron bolt through both, taking care not to touch the rudder, which will prevent the false stern-post from rising up or falling down.

By the guys on the after-part of the rudder, and tackles fixed to them, I may steer the ship. I must take care to bowse taut the tackles on the preventer stern-post to keep it close to the proper stern-post. *Q.* Your

Q. Your ship is leaky, you cannot keep her free by the pumps, what will you do?

A. I will take a spare top-sail or some other sail and spread it upon the deck, cover it all over with oakum, and bind it to the sail with a needle and twine in several places to keep it fast to the sail, then take an hawser and cut it into proper lengths to go under the ship's bottom, and come in over the gunnel, put these hawsers about four feet distance under the sail, and make them fast with their middle to the middle of the sails, each leach beginning at the head and leaving off at the clues:—Then put the sail over board, keeping the oakum side to the ship's bottom, and haul up the ends of the hawsers on the other side by a hauling-line which I have swept the ship with, numbering each end fore and aft; then ease away on the hawser's ends on that side I have put the sail over, and keep hauling at the same time on the hawser's ends, on the opposite side; when the sail is properly down which is known by marking the hawser, I will then clap on tackles, and bowse all taut, keeping the sail close to the ship's bottom the oakum will be drawn in, and stop the leak. The sail may be covered with horse dung or any filth I have on board, which will be drawn in and stop the leak.

Q. Suppose the wind northerly, and you were in a ship's hawse, in the Downs, what would you do?

A. I would wait until the ship tends to windward, and heave up my anchor as she is tending?

Q. How would you work a ship out of the Downs with the wind southerly?

A. I would stand to the Goodwin Sand in 10 or 11 fathoms, it being steep too; and to the shore in 8 fathoms water.

Q. Is there any danger in going out of the Downs?

A. Yes; between Deal and Walmer Castles there are shoals near the shore, not having more than 16 or 17 feet water on them at spring tides; as I draw towards the Foreland, I would stand in shore to 10 or 9 fathoms, and off to the South Sand Head, Upper Deal and Walmer Castles in one, will lead me clear off; Deal Church being open with Walmer Castle about a ship's length, I must stand out till I bring the lights in one, then I am clear of the South Sand Head; and when the light house opens to the westward of Folkstone Church with Hay Cliffs, it leads me clear. I must take care not to shut in the Hope-land, and the South Sand Head will lie off three miles.—To sail out of the Downs to the westward, and the wind at S. W. I will begin to unmoor at a quarter flood, weigh at high water, and cast her in shore. But to sail to the eastward with the wind westerly, I would begin to unmoor at half ebb, take up my best bower, and weigh at low water.

Q. The wind at N. E. in moderate weather you mean to turn up the Swin, at what time of the tide would you weigh?

A. At slack water, loose the sails and up anchor.

Q. What are the marks for running through the Gull Stream?

A. To keep the upper light-house on the South Foreland, in one with the westernmost end of the southernmost clift in Old Staines Bay; which is a swamp that lies between the two clifts a large half mile to the southward of Kingsdown upon the South Foreland.

Q. How do you know when you can weather the South Sand-head?

A. When Upper Deal Mill is open to the Southward of Walmer Castle, or when the light-houses are in one, and Folkstone Church is open with Hay Clift, I am clear.

Q. Suppose

2. Suppose you were coming into the Downs with the wind at S. W. blowing hard, which way would you lay your ship's head to bring her up?

A. I would lay the ship's head to the eastward, and come to with my best bower, but if with the small bower, I would heave her head in shore.

2. For what reason would you do so?

A. I should then keep the cable clear of the cut-water.

2. What is the course from the South Foreland to Dungeness, and what are the dangers?

A. From the South Foreland to Dungeness, the course is S. W. by W.  $\frac{1}{2}$  W. distance 7 leagues.

The Ripraps lie N. E. and S. W. about 5 leagues in length, the N. E. Ends bears from Dover Castle S. S. E. 4 leagues, from Folkestone S. E. by S. Calais steeple bears from it S. E. and Calais Cliffs S. S. E. 3 leagues, the S. W. end bears from Dungeness E. S. E. 4 leagues, on the N. E. part there are but 15 or 16 feet low water, on the S. W. end 4 or 5 fathoms, it is steep too on both sides, having 20 and 22 fathoms close to it. To the westward of Folkestone, there is a ledge of rocks that runs a large mile off the shore, I would come no nearer in than 14 fathoms.

About 4 miles E. by N. from Dungeness, there is a shoal with not more than 12 feet on it, which I shall avoid by keeping in 10 fathoms.

2. Where will you anchor, and in what depth of water under Dungeness?

A. I would anchor with the Nefs Point S. W. by W. the light-house W. S. W. athwart Romney Town, in 8, 9, or 10 fathom water.

There is a shoal about two miles to the westward of the Nefs, with only 18 feet on it at low spring tides the Nefs Light bears from it N. E. by E. 12 fathoms close to it.

2. What is the course from Dungeness to Beachy-head and what are the dangers?

A. W.  $\frac{1}{2}$  S. distance about nine leagues.

Off the high land of Fairleigh, there is a shoal of rocky ground with 14 feet on it, and lies pretty close in. In the channel off Dungeness, there is 24 fathoms and off Beachy-head, from 26 to 30 fathoms, I will, in thick weather, keep in 15 or 20 fathoms, from the Nefs to Beachy-head. When I deepen my water, haul to the northward, but if I shoal it, haul to the southward. In clear weather I may stand in shore until Beachy-head bears W. by N. and not have less than 10 fathoms of water, must then tack to avoid Pemsey Shoal, which lies about two miles off the shore, with Pemsey Church bearing N. and Beachy-head W. by S. 14 feet on it.

There is a shoal with 14 feet on it and lies with Beachy-head W.  $\frac{1}{2}$  N. 7 or 8 miles, Pemsey church N. N. W. 7 miles, and Fairleigh E. by N. 12 miles; E. by S. 6 miles from Beachy-head is the Horse of Willington, a small shoal, having 16 feet on it at low water.

2. Being off Beachy-head, at the close of a winter's even, in a gale of wind at N. E. bound to Spithead, what is the best to be done?

A. I would lie to with my ship's head to the N. N. W. till morning, then she will drive about a channel course at the rate of two knots an hour, allowing that what she would lose in the ebb, she would gain in the flood, and be in a fair way in the morning; I would come no nearer to the Owers than 18 or 20 fathoms.

2. What is the course and dangers between Beachy-head and Dunnoose?

A. The course is W. by N.  $\frac{1}{4}$  N. distance about 20 leagues.

The dangers are, the Owers, the mark to go clear off the east part of them, is the white way on Brow Hill in one with Chichester Church, a little to the

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the eastward of Pegham Church, and the mark to clear the west-end, is St. Rook's Hill in one with Chichester Church, they bear from Culver Cliff E. S. E.  $\frac{1}{2}$  S. about 4 leagues; *there is a floating light on them which has been shifted several Times*; in going down Channel, if I keep Dunnose W. N. W. Northerly, will carry me without them, I will come no nearer to them in thick weather than 18 or 20 fathoms.

Q. You are coming from the westward and off Dunnose, what would you do?

A. I would steer N. E. keeping Sandown Castle clear of Culver Cliff until St. Helen's Mark, which is a white building, is open of the Red Cliff bearing W. by N. then I may run in between Bembridge Ledge and the Princeffa Shoal, but with a ship of a great draught of water, it is best to go without the Princeffa Shoal until I get the Kickergill on the S. W. part of Monkton Fort, and run into Spithead between the Buoy of the Dean and the Buoy of the Warner.

N. B. In going for Spithead from the eastward, there are 5 black buoys lying on the Dean and Horse, they must all be left on the starboard side, the outer one is called the East Buoy of Dean, it lies in 27 feet water, the marks for it are, the flagstaff of Portsmouth platform, a little open to the westward of a round sentry-box of South Sea Castle, bearing N. by W.  $\frac{1}{2}$  W. with Dunnose open of Culver Cliff.

From the outer buoy to the next, is W. N. W. about one mile and a quarter, it lies in 6 fathom; the third, formerly the first buoy of the Dean, lies in 4 fathom; the buoy of the Warner bears west southerly from this buoy about  $1\frac{1}{4}$  mile, from the third to the fourth, or elbow buoy, is S. E. and N. W.; it lies in three fathoms.

The Buoy of the Horse bears from the third buoy N. N. W. about  $1\frac{1}{2}$  mile, and lies in  $3\frac{1}{2}$  fathom; from this last buoy to the first buoy of Sturbridge, is W.  $\frac{1}{2}$  N. the Royal George lies in 13 fathoms,  $\frac{1}{2}$  of a mile to the N. W. of the Edgar, the buoy of the Royal George, that of Norman's Land, and the Kickergill lie all in a line.

The two buoys of the Princeffa Shoal, lie N. E. by N. and S. W. by S. of each other, distance about a mile; they lie each in five fathoms with  $4\frac{1}{2}$  between them, the marks for the inner buoy, which is white, are Sandown Castle one with Culver white Cliff, and Nettleton point on Bembridge Point, the buoy of Bembridge Ledge is black, and the Nob buoy is red, they lie E. N. E. and W. S. W. of each other, with Dunnose open of Culver Cliffs.

Q. Suppose you were to the northward of Bembridge Point, bound to Spithead, and the buoys were all gone, what would you do?

A. I would bring St. Helen's Church to bear W. and keep in twelve fathoms, and steer N. by W. towards the Dean, keeping Ashdown mark above the trees, will lead me into Spithead abreast of Ride; if it is thick weather and the wind southerly, I will come no nearer to Bembridge Ledge than six fathoms, and steer N. W. by N. but if the wind is on the other side, I would come no nearer the Dean and Horse than 10 fathoms; observing the course and tides, I will anchor at Spithead with South Sea Castle N. E. by E. and the Kicker Point N. W. in 14 fathoms. East-India-men and merchant ships generally anchor on the Mother Bank to the westward of the Sturbridge buoy in 10 or 15 fathom; if I am obliged to turn into Spithead, I may turn the Kickergill on each side of Fort Monkton, and come no nearer the Warner than 12 fathoms, nor to the Dean than 9 or 10 fathoms, nor to Norman's Land than 16 or 18 fathoms being close to it.

Q. How do you come to an anchor at St. Helen's?

A. I would keep Sandown Castle just open of Culver Cliffs, and bring St. Helen's Church a sail's breadth open of the Red Cliffs of Bembridge Point, and anchor in 8 or 9 fathoms.

2. Suppose you were moored at Spithead with a cable and an half on the best bower, and one on the small bower, you have orders to sail, at what time of the tide would you unmoor, and which anchor would you take up first?

A. I would begin to unmoor at the first of the flood, and take up my small bower first.

2. In sailing within the Isle of White and through the Needles what are your observations?

A. To keep clear of the West Middle, I would keep South Sea Castle a sail's breadth open of the Kicker Point until I open West Cowes Castle, then steer directly for Hurst Castle, and when abreast of it, borrow pretty near it, then steer for the Needles Point; the leading mark through the Needles is the Light-house in one with Hurst Castle, bearing N. E. by E.  $\frac{1}{4}$  E. I must be careful to keep the Vanes of the Windmill which stands on the Island in sight, to keep me clear of Wardings Ledge; great regard must be had to the tides, for the flood sets on the Needles, and the ebb on the Shingles with great velocity. N. B. To the northward of the West Middle lies the Bramble; the Bramble and West Middle have each two buoys on them, if I sail to the northward of the West Middle I must sail between it and the Bramble, leaving the Bramble on the starboard side; when I come to West Cowes Castle, I must give it a good birth, as there is a ledge of rocks that lie off it: Warding Rock lies on the Island Side with a buoy on it, when I come near the Needles; must give them a good birth to avoid the Chalk Rock\*.

2. What is your course from Dunnose to Portland?

A. W. by N. 16 leagues.

2. If you are forced into Portland, what precautions are necessary?

A. I must take care of the Shambles, they bear from Portland Lights, which lie north and south of each other; N. W. by W. 4 miles with only 14 feet on them at low water; to sail into the Road from the westward, I must keep close to the Bill, and keep my lead going; when I am round the East Point, haul up and anchor against the Pier, in 9 or 10 fathoms, with the Bill bearing S. S. E. Portland Castle S. S. W. and Weymouth Castle N. W. In sailing out of Portland Road, I must keep Week Church open of the Stone Pier, and that will carry me clear to the eastward of the Shambles.

It flows hard from the Road to the Bill E. S. E.  $7\frac{1}{2}$  hours, and the flood sets right of the Bill 9 hours.

N. B. In case I should be embayed to the westward of Portland, and no possibility of getting out, between Burton and Chiswell, were it ebbs 9 hours and flows only 3 hours, there is a steep beach of pebbles, I would there run my ship on shore with as much sail as I could carry, especially at the beginning of an ebb, and remain on board for three or four seas, when I may get on shore with safety.

2. What is the course from Portland to Torbay, and how do you anchor there?

A. The course is W. N. W. and distance about 14 leagues; to anchor in the bay, I would bring the Berry head to bear S. by E. or S. S. E. and Brixham Church on with the Pier Head; the best anchoring for small ships is  $1\frac{1}{2}$  miles from Brixham Pier Head, in 7 fathoms.

2. What is your course from the Berry Head to the Start?

A. S. W. about 6 leagues.

2. Is there any danger near the Start?

\* For a more particular account, see the Directions published by John Hamilton Moore Price 2s. 6d.

A. Yes

*A.* Yes, about 2 miles to the eastward of the Start, there is a shoal with not more than 3 fathom on it, the Bolt Head being kept open of the Start Point will carry me clear of it.

2. What is your course from the Start to the Eddy stone ?

*A.* W.  $\frac{1}{2}$  S. 7 leagues.

2. What is your course from the Start to the Ramhead ?

*A.* W. N. W. 7 leagues.

2. What is to be observed in failing into Plymouth Sound ?

*A.* If coming from the westward, and am got round the Ramhead, I must give Penlee Point a good birth, by reason of a ledge of rocks that lies off from it, then haul N. N. E.  $\frac{1}{2}$  E. for anchoring; the leading mark in, is Plymouth Church, open with the west part of the Citadel.

In going into the sound I may anchor in Causand Bay, in 20 fathoms, with Penlee Point S. W. and the town of Causand W. N. W.

The leading mark to carry me in between the Knap and Shovel, is Plymouth old Church, on with a white patch on the Hoar.

I may go into the Sound on the east side, between the Tinker and Shagstone, by keeping Mount Batton a sail's breadth open of Staden Point, and keep in that direction until Makers Church bears N. W. and Withy Edge opens, then haul over to the eastward and anchor.

2. How do you fail into Hamoaze ?

*A.* I would, keep Kingsand open of Redding Point, until the large House at Stoke touches the East Side of Mill Bay; steer in until the Oblisk comes on with Blockhouse Point; keep in that direction, till the eastermost Summer House on Mount Edgcombe Side, comes open with the Point within which it stands; then steer for it, until the east point of Mount Wise comes open with Block-house Point: then steer mid-channel for Stone-house Pool, till Drake's Island, is shut within Block-house Point: I must not open it till South Down comes open with the Obelisk, then steer up the harbour with the side of Drake's Island, just touching Passage Point, which will lead me to the southward of the Harbour Shoal, on the outer part of which, there is a rock, with only 16 feet on it, but on any other part, there is  $3\frac{1}{2}$  fathoms.

*N.B.* The marks to know the Sound when I am coming from sea in the day time, are, Ram Church, which stands to the north-ward of the Ram-head, and a square tower standing on the highest part of the land.

2. You are bound into Falmouth, how would you proceed ?

*A.* In going into Falmouth there is a rock, called the Block Rock, with a pole on it, and shews itself at half tide; it lies nearest to the west shore; I may fail in on either side of it, but the east side is the best. If I would fail into Carrick Road, I must keep in the fair way, and my lead going, as there is a narrow deep channel all the way, of 16 or 18 fathom. I may borrow on St. Maw's side in 5 or 6 fathom. The best anchoring in Carrick Road, is St. Maw's Castle, E.S.E. and lay my eastermost anchor in 16 or 18 fathoms, and my westermost anchor in 4 or 5 fathoms. Just past St. Maw's there is a sand that is steep to, called St. Maw's Sand, and lies almost half channel over.

*N.B.* Great ships anchor, with Manacle Point, on with the Point of Falmouth, or a great house, that is to the westward of Penryn, just open Trefusis Point in 18 fathom.—The Manacles lie from Falmouth about S.S.E.

2. How do you know the Lizard when you first make it ?

*A.* It is the southermost land on the coast, and may be seen 7 or 8 leagues off, in 42 fathoms.

2. How does the Lands End appear when you make it ?

*A.* It appears in hummocks with a church on it, and may be seen 7 or 8 leagues off, in 54 fathoms.



Q. What are the dangers off the Land's End ?

A. Many :— 1st, The Runnel-stone lies about  $1 \frac{1}{2}$  mile S. S. W. from Toll-peden-penwith.

2d, N. E. by N. from the Runnel-stone, there is a rock, called the Leaw-mean, which appears at half ebb, with a passage between it and the main, seldom used by any but coasters.

3d, The Wolf Rock, bears from the Land's End S. W. by W. distance 3 leagues; it is small and may be seen at half tide; the largest of the Brazen Rocks, kept open of the outermost of the Long Ships (*on which there is a light-house erected*) will lead me clear to the westward of the Wolf.

4th, The Long Ships lie N. W. by N. about 3 miles from the S. W. point of the Land's End, and 1 mile W. N. W. from the westernmost point, they are high, and may be seen 4 or 5 leagues off.

5th, The Kettle Bottom, is a shoal with only 6 feet on it, and lies about half way between the nethermost part of the Long Ships, and the west point of the Land's End.

6th, The Bresam Rocks lie about 3 miles N. E. by N. from the Long Ships.

7th, The Seven Stones are a row of rocks that come not above water, but the sea always break over them; they lie from the Land's End W. S. W.  $\frac{1}{2}$  S. dist. 7 leagues; and from St. Martin's Head, Scilly, N. N. E. dist. 3 leagues.

Q. If you are forced into Mount's Bay, where would be the safest anchoring ground ?

A. Mount's Bay lies between the Lizard and the Land's End; there is a high Island on the east side, and a Castle on the west side of it, called St. Michael's Mount; from the east side of it lies a ledge of rocks, near a league into the sea: the Coast is full of rocks, and not safe to anchor in. To sail into the bay I must bring St. Paul's steeple W. and keep over to the west shore, and make St. Clement's Island, which is before the town of Mousehole, having the castle on the starboard side; I shall then see a large sandy bay, and, when within the Island, there is a good anchoring in 7 or 8 fathoms land-locked from all winds but a S. E. wind.

Q. If you are bound, or forced to go into Scilly, what would you do ?

A. I would steer for St. Mary's Sound, and run in for the southernmost point of St. Mary's Island, called Penninis Point, minding to keep the lead going, and approach no nearer than 5 fathoms water; about N. W. of Penninis Point, a little more than half a mile, is the Woolpack, the shoal lies near to the shore; I must continue to run in 5 or 6 fathoms, keeping pretty close to St. Mary's Island to avoid the Spanish Ledge, which lies about half a mile W. by S. from Penninis Point; some part of this shoal may be seen at low water, and part of the Woolpack shows itself before low water. when I have got abreast of the Woolpack, to which I must give a good birth, about a cable's length, and steer for the Stevel Rock, which is bold to; when I am abreast of the Stevel, must steer N. W. by W. until Little Crow Island comes on with Bantscarren Point; then steer N. N. E. until Crow Island comes open a ship's length of Bantscarren Point, or bring the castle, which is on St. Mary's Island to bear S. S. E. and anchor in 6 or 5 fathoms water.

N. B. The foregoing Questions and Answers have been examined by several experienced Naval Officers, who only disagreed in some particulars respecting the working of a ship at sea. Others, indeed, who pretended to great Nautical Knowledge, could do little more than quibble and carp at parts they seemed unable to amend. As I do not take upon myself to determine which of them was right, it is hoped, every judicious mariner will excuse any errors he may find in the above, which is principally intended to fix the attention, and facilitate the speedy improvement of young practitioners in seaman'ship.

REMARKS

REMARKS  
CALCULATED TO ASSIST  
COMMANDERS  
WHEN COMING INTO  
THE BRITISH CHANNEL.

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AS Mariners know that their reckonings are always uncertain, in proportion to the length of their several passages from the times of their last departures, it is natural to suppose, that they must, when approaching to any difficult and dangerous navigation, experience great anxiety of mind for the issue. As the British Channel has proved fatal to many, it may fairly be ranked among those places which are deemed dangerous to ships, in their approach after long passages; and, therefore, all those who are entrusted with the conducting of ships thro' it, ought to acquire such knowledge as may enable them to perform the duties of their important office. Channel coasters, by the frequency of their passing and repassing through it, acquire such knowledge as those who are employed in foreign voyages cannot pretend to: hence it becomes necessary to furnish the latter with some useful information; more especially, as it is next to impossible for the human mind, when engaged in various pursuits, to remember every necessary article, such as the course and distance from one place to another, the precise situation of rocks and shoals, and the direction and strength of the tide in the various places. Commanders of ships, when coming from abroad, and about to enter the British Channel, must be exceedingly anxious to accomplish the ultimate design of their voyage, by bringing their respective ships safely in to port. To the assistance of such, the following observations are intended to contribute: they are founded on experience, and will, if properly observed, prove highly serviceable; especially when long nights, or thick weather, augment those dangers which attend the Channel navigation.

Ships, in approaching the Channel from a long passage, should not only try for soundings in time, but run, if possible, in the latitude of  $49^{\circ} 2'$  North. Having, in that parallel, got soundings in 82 fathoms, fine white sand with black and yellow specks, you may be sure that you are near the outer edge of the bank; and about 50 leagues to the westward of Scilly. By running 16 or 17 leagues further to the eastward, in the same parallel of latitude, you will have 90 fathoms, fine white sand; and continuing to run 4 leagues more to the eastward, you will shoalen your water to 82 fathoms. Soon afterwards, you will have 72 and 75 fathoms, fine white sand with sometimes a mixture of green; and in proceeding 16 or 17 leagues further to the eastward, in this latitude, you will have 72, 75, 77, and 70 fathoms. The soundings will be, for the most part, fine sand, but different in colour: some of them will be white sand, mixed with yellow specks; and others fine green sand, with some mud. In the latitude of  $48^{\circ} 23'$  North, and 61 leagues to the westward of Ushant, lies the Sole Bank. It stretches about S. S. E. and N. N. W. 12 leagues in length and 4 in breadth; and has 64 fathoms on it, fine grey sand.

The

*The following are the Soundings in the Parallels of 48° 20', and 48° 30', with their several Depth of Water and Distances from the Island of Ushant.*

| Dist. from<br>Ushant. | QUALITY OF THE SOUNDINGS.                                                            | Depth in<br>Fathoms. |
|-----------------------|--------------------------------------------------------------------------------------|----------------------|
| Leagues.              |                                                                                      |                      |
| 52 —                  | Fine grey sand, mixed with black, - -                                                | — 92                 |
| 49 —                  | { Fine grey sand, mixed with small shells and<br>broken bits - - - - }               | — 106                |
| 46 —                  | Grey sand mixed with bits of brown shells - -                                        | — 110                |
| 43 —                  | { Grey sand mixed with bits of shells and brown<br>sand - - - - }                    | — 108                |
| 40 —                  | Grey sand, mixed with bits of shells and gravel - -                                  | — 117                |
| 37 —                  | Grey sand, mixed with shells and gravel - -                                          | — 104                |
| 35 —                  | Grey sand, mixed with small cornet shells - -                                        | — 110                |
| 32 —                  | Sand mixed with gravel, shells, and small cornets - -                                | — 108                |
| 29 —                  | Whitish grey sand and flat stones - - -                                              | — 108                |
| 24 —                  | Light grey sand, with bits of shells - - -                                           | — 100                |
| 21 —                  | Coarse sand, with bits of cockle shells - -                                          | — 98                 |
| 18 —                  | { Light grey sand, with bits of brown and yel-<br>low shells, and small stones - - } | — 90                 |
| 15 —                  | Light grey sand, mixed with barley-beards - -                                        | — 84                 |
| 14 —                  | Whitish grey sand, bits of shells and fine cornets - -                               | — 80                 |
| 11 —                  | { Light grey sand, mixed with barley beards<br>and small shells - - - }              | — 79                 |
| 9 —                   | Fine grey sand, with bits of shells - - -                                            | — 75                 |
| 8 —                   | { Grey sand, spotted with red, and mixed with<br>bits of shells - - - }              | — 75                 |
| 6 —                   | Whitish coarse shining sand, with fine shells - -                                    | — 70                 |
| 4 —                   | { Whitish coarse shining sand, mixed with bar-<br>ley beards and coral - - - }       | — 65                 |
| 2 —                   | Whitish coarse sand - - - - -                                                        | — 64                 |

When running for the channel in latitude 49° 25', which is the best latitude, and you have run so far to the eastward as to shoalen your water to 65 or 67 fathoms, and the soundings are shells and small yellow stones or red sand, you may thence conclude that you are abreast of Scilly; or if you have 68 fathoms, white sand with grey specks, and sometimes shells and stones, Scilly will then bear about N. E. from you, distance 10 leagues. Your soundings will always inform you whether you are to the northward or southward of Scilly. In the latitude of Scilly you will have oazy ground, in 60, 65, 75, or 80 fathoms. W. N. W. 10 leagues from Scilly, lies Jones's Bank, on which you will have but 30, 35, and 40 fathoms; and, a little to the southward of it, you will have 72 and 75 fathoms. In running for the channel, in the latitude of 49° 30', you will have the following depths of water and soundings, when you are abreast Scilly; namely, 60 fathoms, oaze and broken shells; 64 fathoms, white sand with grey specks; 65 fathoms, shells and stones; and 55 fathoms, fine grey sand. The soundings



soundings near Scilly, are very different from all others in this latitude: pieces of rotten rock as broad as a small bean, and of a stone colour, will come up with the lead, which will not be the case any where else in the same parallel. More to the southward you will have deep water, with fine sand, interspersed with black specks like ground pepper. In the night, or in foggy weather, you should come no nearer Scilly than 60 fathoms; for, in that depth, you will not be more than 6 or 7 leagues from it. Abreast of Scilly, in the latitude of  $49^{\circ} 20'$ , you will have 70 fathoms, branny or yellow and white sand; and to the eastward of Scilly, in the latitude of  $49^{\circ} 8'$ , you will have 56 or 58 fathoms, coarse sand. You should then steer more to the northward, and endeavour to make the land about the Lizard; you may safely make it in the night, as well as in the day, if the weather be clear: for the Light-Houses stand so high, and the Coast is so clear, that you may, without danger, come within half a mile of the point. If the weather prove so thick that you cannot safely make the land, come no nearer to the Lizard than 45 fathoms; for, in that depth you will not be more than three leagues off the point: your soundings there will be pebble stones and scallop shells.

Ships, when coming into the channel, ought always, if possible, to make the land about the Lizard: because it is the properest place for a land-fall: and should they afterwards meet with thick weather, which frequently happens, they will not only know how to steer, but also how they advance up the channel, which will become more and more necessary in proportion to the contraction of its boundaries. Some, by neglecting this precaution, have, contrary to their expectation, got on the south side of the channel. This error is greatly owing to the strong indraught between the islands of Guernsey and Jersey, and the coast of Brittany, which ought always to be guarded against, especially in thick weather. It frequently happens that ships, coming into the channel, have not had an observation for some days back, which, together with the operation of scant and contrary winds, and the setting of the tides, tend to perplex and bewilder the most experienced mariner, when thick weather prevents him from getting a sight of the land. The variation of the compass in the entrance of the channel, taken on board of his Majesty's ship Europe, in October, 1782, was  $23^{\circ} 14'$  W. but as the variation is continually increasing, at the rate of about a degree in every 5 years and a half, it will be necessary to add 11 minutes for every year, subsequent to the year 1782, which will give you the variation at any time pretty exact.

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| <i>Latitudes and Longitudes of Places</i>                                                                        | — | — | XXIV    |

TABLE I. MERIDIONAL PARTS.

| M  | 0 <sup>d</sup> | 1 <sup>d</sup> | 2 <sup>d</sup> | 3 <sup>d</sup> | 4 <sup>d</sup> | 5 <sup>d</sup> | 6 <sup>d</sup> | 7 <sup>d</sup> | 8 <sup>d</sup> | 9 <sup>d</sup> | 10 <sup>c</sup> | 11 <sup>d</sup> | 12 <sup>d</sup> | 13 <sup>d</sup> | M  |
|----|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------------|-----------------|-----------------|-----------------|----|
| 0  | 0              | 60             | 120            | 180            | 240            | 300            | 361            | 421            | 482            | 542            | 603             | 664             | 725             | 787             | 0  |
| 1  | 1              | 61             | 121            | 181            | 241            | 301            | 362            | 422            | 483            | 543            | 604             | 665             | 726             | 788             | 1  |
| 2  | 2              | 62             | 122            | 182            | 242            | 302            | 363            | 423            | 484            | 544            | 605             | 666             | 727             | 789             | 2  |
| 3  | 3              | 63             | 123            | 183            | 243            | 303            | 364            | 424            | 485            | 545            | 606             | 667             | 728             | 790             | 3  |
| 4  | 4              | 64             | 124            | 184            | 244            | 304            | 365            | 425            | 486            | 546            | 607             | 668             | 729             | 791             | 4  |
| 5  | 5              | 65             | 125            | 185            | 245            | 305            | 366            | 426            | 487            | 547            | 608             | 669             | 730             | 792             | 5  |
| 6  | 6              | 66             | 126            | 186            | 246            | 306            | 367            | 427            | 488            | 548            | 609             | 670             | 731             | 793             | 6  |
| 7  | 7              | 67             | 127            | 187            | 247            | 307            | 368            | 428            | 489            | 549            | 610             | 671             | 732             | 794             | 7  |
| 8  | 8              | 68             | 128            | 188            | 248            | 308            | 369            | 429            | 490            | 550            | 611             | 672             | 733             | 795             | 8  |
| 9  | 9              | 69             | 129            | 189            | 249            | 309            | 370            | 430            | 491            | 551            | 612             | 673             | 735             | 796             | 9  |
| 10 | 10             | 70             | 130            | 190            | 250            | 310            | 371            | 431            | 492            | 552            | 613             | 674             | 736             | 797             | 10 |
| 11 | 11             | 71             | 131            | 191            | 251            | 311            | 372            | 432            | 493            | 553            | 614             | 675             | 737             | 798             | 11 |
| 12 | 12             | 72             | 132            | 192            | 252            | 312            | 373            | 433            | 494            | 554            | 615             | 676             | 738             | 799             | 12 |
| 13 | 13             | 73             | 133            | 193            | 253            | 313            | 374            | 434            | 495            | 555            | 616             | 677             | 739             | 800             | 13 |
| 14 | 14             | 74             | 134            | 194            | 254            | 314            | 375            | 435            | 496            | 556            | 617             | 678             | 740             | 801             | 14 |
| 15 | 15             | 75             | 135            | 195            | 255            | 315            | 376            | 436            | 497            | 557            | 618             | 679             | 741             | 802             | 15 |
| 16 | 16             | 76             | 136            | 196            | 256            | 316            | 377            | 437            | 498            | 558            | 619             | 680             | 742             | 803             | 16 |
| 17 | 17             | 77             | 137            | 197            | 257            | 317            | 378            | 438            | 499            | 559            | 620             | 681             | 743             | 804             | 17 |
| 18 | 18             | 78             | 138            | 198            | 258            | 318            | 379            | 439            | 500            | 560            | 621             | 682             | 744             | 805             | 18 |
| 19 | 19             | 79             | 139            | 199            | 259            | 319            | 380            | 440            | 501            | 561            | 622             | 683             | 745             | 806             | 19 |
| 20 | 20             | 80             | 140            | 200            | 260            | 320            | 381            | 441            | 502            | 562            | 623             | 684             | 746             | 807             | 20 |
| 21 | 21             | 81             | 141            | 201            | 261            | 321            | 382            | 442            | 503            | 563            | 624             | 685             | 747             | 808             | 21 |
| 22 | 22             | 82             | 142            | 202            | 262            | 322            | 383            | 443            | 504            | 564            | 625             | 686             | 748             | 809             | 22 |
| 23 | 23             | 83             | 143            | 203            | 263            | 323            | 384            | 444            | 505            | 565            | 626             | 688             | 749             | 810             | 23 |
| 24 | 24             | 84             | 144            | 204            | 264            | 324            | 385            | 445            | 506            | 566            | 627             | 689             | 750             | 811             | 24 |
| 25 | 25             | 85             | 145            | 205            | 265            | 325            | 386            | 446            | 507            | 567            | 628             | 690             | 751             | 812             | 25 |
| 26 | 26             | 86             | 146            | 206            | 266            | 326            | 387            | 447            | 508            | 568            | 629             | 691             | 752             | 813             | 26 |
| 27 | 27             | 87             | 147            | 207            | 267            | 327            | 388            | 448            | 509            | 569            | 630             | 692             | 753             | 814             | 27 |
| 28 | 28             | 88             | 148            | 208            | 268            | 328            | 389            | 449            | 510            | 570            | 632             | 693             | 754             | 816             | 28 |
| 29 | 29             | 89             | 149            | 209            | 269            | 329            | 390            | 450            | 511            | 571            | 633             | 694             | 755             | 817             | 29 |
| 30 | 30             | 90             | 150            | 210            | 270            | 330            | 391            | 451            | 512            | 573            | 634             | 695             | 756             | 818             | 30 |
| 31 | 31             | 91             | 151            | 211            | 271            | 332            | 392            | 452            | 513            | 574            | 635             | 696             | 757             | 819             | 31 |
| 32 | 32             | 92             | 152            | 212            | 272            | 333            | 393            | 453            | 514            | 575            | 636             | 697             | 758             | 820             | 32 |
| 33 | 33             | 93             | 153            | 213            | 273            | 334            | 394            | 454            | 515            | 576            | 637             | 698             | 759             | 821             | 33 |
| 34 | 34             | 94             | 154            | 214            | 274            | 335            | 395            | 455            | 516            | 577            | 638             | 699             | 760             | 822             | 34 |
| 35 | 35             | 95             | 155            | 215            | 275            | 336            | 396            | 456            | 517            | 578            | 639             | 700             | 761             | 823             | 35 |
| 36 | 36             | 96             | 156            | 216            | 276            | 337            | 397            | 457            | 518            | 579            | 640             | 701             | 762             | 824             | 36 |
| 37 | 37             | 97             | 157            | 217            | 277            | 338            | 398            | 458            | 519            | 580            | 641             | 702             | 763             | 825             | 37 |
| 38 | 38             | 98             | 158            | 218            | 278            | 339            | 399            | 459            | 520            | 581            | 642             | 703             | 764             | 826             | 38 |
| 39 | 39             | 99             | 159            | 219            | 279            | 340            | 400            | 460            | 521            | 582            | 643             | 704             | 765             | 827             | 39 |
| 40 | 40             | 100            | 160            | 220            | 280            | 341            | 401            | 461            | 522            | 583            | 644             | 705             | 766             | 828             | 40 |
| 41 | 41             | 101            | 161            | 221            | 281            | 342            | 402            | 462            | 523            | 584            | 645             | 706             | 767             | 829             | 41 |
| 42 | 42             | 102            | 162            | 222            | 282            | 343            | 403            | 463            | 524            | 585            | 646             | 707             | 768             | 830             | 42 |
| 43 | 43             | 103            | 163            | 223            | 283            | 344            | 404            | 464            | 525            | 586            | 647             | 708             | 769             | 831             | 43 |
| 44 | 44             | 104            | 164            | 224            | 284            | 345            | 405            | 465            | 526            | 587            | 648             | 709             | 770             | 832             | 44 |
| 45 | 45             | 105            | 165            | 225            | 285            | 346            | 406            | 466            | 527            | 588            | 649             | 710             | 771             | 833             | 45 |
| 46 | 46             | 106            | 166            | 226            | 286            | 347            | 407            | 467            | 528            | 589            | 650             | 711             | 772             | 835             | 46 |
| 47 | 47             | 107            | 167            | 227            | 287            | 348            | 408            | 468            | 529            | 590            | 651             | 712             | 773             | 835             | 47 |
| 48 | 48             | 108            | 168            | 228            | 288            | 349            | 409            | 469            | 530            | 591            | 652             | 713             | 774             | 836             | 48 |
| 49 | 49             | 109            | 169            | 229            | 289            | 350            | 410            | 470            | 531            | 592            | 653             | 714             | 775             | 837             | 49 |
| 50 | 50             | 110            | 170            | 230            | 290            | 351            | 411            | 471            | 532            | 593            | 654             | 715             | 776             | 838             | 50 |
| 51 | 51             | 111            | 171            | 231            | 291            | 352            | 412            | 472            | 533            | 594            | 655             | 716             | 777             | 839             | 51 |
| 52 | 52             | 112            | 172            | 232            | 292            | 353            | 413            | 473            | 534            | 595            | 656             | 717             | 779             | 840             | 52 |
| 53 | 53             | 113            | 173            | 233            | 293            | 354            | 414            | 474            | 535            | 596            | 657             | 718             | 780             | 841             | 53 |
| 54 | 54             | 114            | 174            | 234            | 294            | 355            | 415            | 475            | 536            | 597            | 658             | 719             | 781             | 842             | 54 |
| 55 | 55             | 115            | 175            | 235            | 295            | 356            | 416            | 477            | 537            | 598            | 659             | 720             | 782             | 843             | 55 |
| 56 | 56             | 116            | 176            | 236            | 296            | 357            | 417            | 478            | 538            | 599            | 660             | 721             | 783             | 844             | 56 |
| 57 | 57             | 117            | 177            | 237            | 297            | 358            | 418            | 479            | 539            | 600            | 661             | 722             | 785             | 845             | 57 |
| 58 | 58             | 118            | 178            | 238            | 298            | 359            | 419            | 480            | 540            | 601            | 662             | 723             | 784             | 846             | 58 |
| 59 | 59             | 119            | 179            | 239            | 299            | 360            | 420            | 481            | 541            | 602            | 663             | 724             | 786             | 847             | 59 |



TABLE I. MERIDIONAL PARTS.

| M  | 14 <sup>d</sup> | 15 <sup>d</sup> | 16 <sup>d</sup> | 17 <sup>d</sup> | 18 <sup>d</sup> | 19 <sup>d</sup> | 20 <sup>d</sup> | 21 <sup>d</sup> | 22 <sup>d</sup> | 23 <sup>d</sup> | 24 <sup>d</sup> | 25 <sup>d</sup> | 26 <sup>d</sup> | 27 <sup>d</sup> | M  |
|----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----|
| 0  | 848             | 910             | 973             | 1035            | 1098            | 1161            | 1225            | 1289            | 1354            | 1419            | 1484            | 1550            | 1616            | 1684            | 0  |
| 1  | 849             | 911             | 974             | 36              | 99              | 63              | 26              | 90              | 55              | 20              | 85              | 51              | 18              | 85              | 1  |
| 2  | 851             | 913             | 975             | 37              | 100             | 64              | 27              | 91              | 56              | 21              | 86              | 52              | 19              | 86              | 2  |
| 3  | 852             | 914             | 976             | 38              | 01              | 65              | 28              | 92              | 57              | 22              | 87              | 53              | 20              | 87              | 3  |
| 4  | 853             | 915             | 977             | 39              | 02              | 66              | 29              | 93              | 58              | 23              | 88              | 54              | 21              | 88              | 4  |
| 5  | 854             | 916             | 978             | 41              | 03              | 67              | 30              | 94              | 59              | 24              | 90              | 56              | 22              | 89              | 5  |
| 6  | 855             | 917             | 979             | 42              | 05              | 68              | 32              | 96              | 60              | 25              | 91              | 57              | 23              | 90              | 6  |
| 7  | 856             | 918             | 980             | 43              | 06              | 69              | 33              | 97              | 61              | 26              | 92              | 58              | 24              | 91              | 7  |
| 8  | 857             | 919             | 981             | 44              | 07              | 70              | 34              | 98              | 62              | 27              | 93              | 59              | 25              | 92              | 8  |
| 9  | 858             | 920             | 982             | 45              | 08              | 71              | 35              | 99              | 63              | 28              | 94              | 60              | 26              | 93              | 9  |
| 10 | 859             | 921             | 983             | 1046            | 1109            | 1172            | 1236            | 1300            | 1364            | 1429            | 1495            | 1561            | 1628            | 1695            | 10 |
| 11 | 860             | 922             | 984             | 47              | 10              | 73              | 37              | 01              | 66              | 31              | 96              | 62              | 29              | 96              | 11 |
| 12 | 861             | 923             | 985             | 48              | 11              | 74              | 38              | 02              | 67              | 32              | 97              | 63              | 30              | 97              | 12 |
| 13 | 862             | 924             | 986             | 49              | 12              | 75              | 39              | 03              | 68              | 33              | 98              | 64              | 31              | 98              | 13 |
| 14 | 863             | 925             | 987             | 50              | 13              | 76              | 40              | 04              | 69              | 34              | 99              | 65              | 32              | 99              | 14 |
| 15 | 864             | 926             | 988             | 51              | 14              | 77              | 41              | 05              | 70              | 35              | 100             | 67              | 33              | 100             | 15 |
| 16 | 865             | 927             | 989             | 52              | 15              | 78              | 42              | 06              | 71              | 36              | 02              | 68              | 34              | 01              | 16 |
| 17 | 866             | 928             | 990             | 53              | 16              | 80              | 43              | 07              | 72              | 37              | 03              | 69              | 35              | 02              | 17 |
| 18 | 867             | 929             | 991             | 54              | 17              | 81              | 44              | 08              | 73              | 38              | 04              | 70              | 37              | 03              | 18 |
| 19 | 868             | 930             | 992             | 55              | 18              | 82              | 45              | 10              | 74              | 39              | 05              | 71              | 38              | 04              | 19 |
| 20 | 869             | 931             | 994             | 1056            | 1119            | 1183            | 1247            | 1311            | 1375            | 1440            | 1506            | 1572            | 1639            | 1706            | 20 |
| 21 | 870             | 932             | 995             | 57              | 20              | 84              | 48              | 12              | 76              | 41              | 07              | 73              | 40              | 07              | 21 |
| 22 | 871             | 933             | 996             | 58              | 21              | 85              | 49              | 13              | 77              | 43              | 08              | 74              | 41              | 08              | 22 |
| 23 | 872             | 934             | 997             | 59              | 22              | 86              | 50              | 14              | 79              | 44              | 09              | 75              | 42              | 09              | 23 |
| 24 | 873             | 935             | 998             | 60              | 23              | 87              | 51              | 15              | 80              | 45              | 10              | 77              | 43              | 10              | 24 |
| 25 | 874             | 936             | 999             | 61              | 25              | 88              | 52              | 16              | 81              | 46              | 11              | 78              | 44              | 11              | 25 |
| 26 | 875             | 937             | 1000            | 63              | 26              | 89              | 53              | 17              | 82              | 47              | 13              | 79              | 45              | 12              | 26 |
| 27 | 876             | 938             | 1001            | 64              | 27              | 90              | 54              | 18              | 83              | 48              | 14              | 80              | 47              | 13              | 27 |
| 28 | 877             | 939             | 1002            | 65              | 28              | 91              | 55              | 19              | 84              | 49              | 15              | 81              | 48              | 14              | 28 |
| 29 | 878             | 941             | 1003            | 66              | 29              | 92              | 56              | 20              | 85              | 50              | 16              | 82              | 49              | 15              | 29 |
| 30 | 879             | 942             | 1004            | 1067            | 1130            | 1193            | 1257            | 1321            | 1386            | 1451            | 1517            | 1583            | 1650            | 1717            | 30 |
| 31 | 880             | 943             | 05              | 68              | 31              | 94              | 58              | 22              | 87              | 52              | 18              | 84              | 51              | 16              | 31 |
| 32 | 881             | 944             | 06              | 69              | 32              | 95              | 59              | 24              | 88              | 53              | 19              | 85              | 52              | 17              | 32 |
| 33 | 883             | 945             | 07              | 70              | 33              | 96              | 60              | 25              | 89              | 55              | 20              | 86              | 53              | 18              | 33 |
| 34 | 884             | 946             | 08              | 71              | 34              | 97              | 61              | 26              | 90              | 56              | 21              | 88              | 54              | 19              | 34 |
| 35 | 885             | 947             | 09              | 72              | 35              | 99              | 62              | 27              | 92              | 57              | 22              | 89              | 56              | 20              | 35 |
| 36 | 886             | 948             | 10              | 73              | 36              | 100             | 64              | 28              | 93              | 58              | 24              | 90              | 57              | 21              | 36 |
| 37 | 887             | 949             | 11              | 74              | 37              | 01              | 65              | 29              | 94              | 59              | 25              | 91              | 58              | 22              | 37 |
| 38 | 888             | 950             | 12              | 75              | 38              | 02              | 66              | 30              | 95              | 60              | 26              | 92              | 59              | 23              | 38 |
| 39 | 889             | 951             | 13              | 76              | 39              | 03              | 67              | 31              | 96              | 61              | 27              | 93              | 60              | 24              | 39 |
| 40 | 890             | 952             | 1014            | 1077            | 1140            | 1204            | 1268            | 1332            | 1397            | 1462            | 1528            | 1594            | 1661            | 1729            | 40 |
| 41 | 891             | 953             | 15              | 78              | 41              | 05              | 69              | 33              | 98              | 63              | 29              | 95              | 62              | 25              | 41 |
| 42 | 892             | 954             | 16              | 79              | 42              | 06              | 70              | 34              | 99              | 64              | 30              | 96              | 63              | 26              | 42 |
| 43 | 893             | 955             | 18              | 80              | 44              | 07              | 71              | 35              | 100             | 65              | 31              | 98              | 64              | 27              | 43 |
| 44 | 894             | 956             | 19              | 81              | 45              | 08              | 72              | 36              | 01              | 67              | 32              | 99              | 66              | 28              | 44 |
| 45 | 895             | 957             | 20              | 82              | 46              | 09              | 73              | 38              | 02              | 68              | 33              | 100             | 67              | 29              | 45 |
| 46 | 896             | 958             | 21              | 83              | 47              | 10              | 74              | 39              | 03              | 69              | 35              | 01              | 68              | 30              | 46 |
| 47 | 897             | 959             | 22              | 85              | 48              | 11              | 75              | 40              | 05              | 70              | 36              | 02              | 69              | 31              | 47 |
| 48 | 898             | 960             | 23              | 86              | 49              | 12              | 76              | 41              | 06              | 71              | 37              | 03              | 70              | 32              | 48 |
| 49 | 899             | 961             | 24              | 87              | 50              | 13              | 77              | 42              | 07              | 72              | 38              | 04              | 71              | 33              | 49 |
| 50 | 900             | 962             | 1025            | 1088            | 1151            | 1214            | 1278            | 1343            | 1408            | 1473            | 1539            | 1605            | 1672            | 1740            | 50 |
| 51 | 901             | 963             | 26              | 89              | 52              | 16              | 80              | 44              | 09              | 74              | 40              | 06              | 73              | 41              | 51 |
| 52 | 902             | 964             | 27              | 90              | 53              | 17              | 81              | 45              | 10              | 75              | 41              | 08              | 75              | 42              | 52 |
| 53 | 903             | 965             | 28              | 91              | 54              | 18              | 82              | 46              | 11              | 76              | 42              | 09              | 76              | 43              | 53 |
| 54 | 904             | 966             | 29              | 92              | 55              | 19              | 83              | 47              | 12              | 77              | 43              | 10              | 77              | 44              | 54 |
| 55 | 905             | 968             | 30              | 93              | 56              | 20              | 84              | 48              | 13              | 79              | 44              | 11              | 78              | 45              | 55 |
| 56 | 906             | 969             | 31              | 94              | 57              | 21              | 85              | 49              | 14              | 80              | 46              | 12              | 79              | 46              | 56 |
| 57 | 907             | 970             | 32              | 95              | 58              | 22              | 86              | 50              | 15              | 81              | 47              | 13              | 80              | 47              | 57 |
| 58 | 908             | 971             | 33              | 96              | 59              | 23              | 87              | 52              | 16              | 82              | 48              | 14              | 81              | 48              | 58 |
| 59 | 909             | 972             | 34              | 97              | 60              | 24              | 88              | 53              | 18              | 83              | 49              | 15              | 82              | 49              | 59 |

TABLE I. MERIDIONAL PARTS.

| M  | 28 <sup>d</sup> | 29 <sup>d</sup> | 30 <sup>d</sup> | 31 <sup>d</sup> | 32 <sup>d</sup> | 33 <sup>d</sup> | 34 <sup>d</sup> | 35 <sup>d</sup> | 36 <sup>d</sup> | 37 <sup>d</sup> | 38 <sup>d</sup> | 39 <sup>d</sup> | 40 <sup>d</sup> | 41 <sup>d</sup> | M  |
|----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----|
| 0  | 1751            | 1819            | 1888            | 1958            | 2028            | 2100            | 2171            | 2244            | 2318            | 2393            | 2468            | 2545            | 2623            | 2702            | 0  |
| 1  | 52              | 21              | 90              | 59              | 30              | 01              | 73              | 45              | 19              | 94              | 70              | 46              | 24              | 03              | 1  |
| 2  | 53              | 22              | 91              | 60              | 31              | 02              | 74              | 47              | 20              | 95              | 71              | 48              | 25              | 04              | 2  |
| 3  | 55              | 23              | 92              | 62              | 32              | 03              | 75              | 48              | 22              | 96              | 72              | 49              | 27              | 06              | 3  |
| 4  | 56              | 24              | 93              | 63              | 34              | 04              | 76              | 49              | 23              | 98              | 73              | 50              | 28              | 07              | 4  |
| 5  | 57              | 25              | 94              | 64              | 35              | 05              | 78              | 50              | 24              | 99              | 75              | 51              | 29              | 08              | 5  |
| 6  | 58              | 26              | 95              | 65              | 36              | 07              | 79              | 52              | 25              | 2400            | 76              | 53              | 31              | 10              | 6  |
| 7  | 59              | 27              | 96              | 66              | 37              | 08              | 80              | 53              | 27              | 01              | 77              | 54              | 32              | 11              | 7  |
| 8  | 60              | 29              | 98              | 67              | 38              | 09              | 81              | 54              | 28              | 03              | 78              | 55              | 33              | 12              | 8  |
| 9  | 61              | 30              | 99              | 69              | 39              | 10              | 82              | 55              | 29              | 04              | 80              | 57              | 34              | 14              | 9  |
| 10 | 1762            | 1831            | 1900            | 1970            | 2040            | 2111            | 2184            | 2256            | 2330            | 2405            | 2481            | 2558            | 2636            | 2715            | 10 |
| 11 | 64              | 32              | 01              | 71              | 41              | 13              | 85              | 58              | 32              | 06              | 82              | 59              | 37              | 16              | 11 |
| 12 | 65              | 33              | 02              | 72              | 43              | 14              | 86              | 59              | 33              | 08              | 84              | 60              | 38              | 18              | 12 |
| 13 | 66              | 34              | 03              | 73              | 44              | 15              | 87              | 60              | 34              | 09              | 85              | 62              | 40              | 19              | 13 |
| 14 | 67              | 35              | 05              | 74              | 45              | 16              | 88              | 61              | 35              | 10              | 86              | 63              | 41              | 20              | 14 |
| 15 | 68              | 37              | 06              | 76              | 46              | 17              | 90              | 63              | 37              | 11              | 87              | 64              | 42              | 22              | 15 |
| 16 | 69              | 38              | 07              | 77              | 47              | 19              | 91              | 64              | 38              | 13              | 89              | 66              | 44              | 23              | 16 |
| 17 | 70              | 39              | 08              | 78              | 48              | 20              | 92              | 65              | 39              | 14              | 90              | 67              | 45              | 24              | 17 |
| 18 | 72              | 40              | 09              | 79              | 50              | 21              | 93              | 66              | 40              | 15              | 91              | 68              | 46              | 26              | 18 |
| 19 | 73              | 41              | 10              | 80              | 51              | 22              | 94              | 68              | 42              | 16              | 92              | 69              | 48              | 27              | 19 |
| 20 | 1774            | 1842            | 1911            | 1981            | 2052            | 2123            | 2196            | 2269            | 2343            | 2418            | 2494            | 2571            | 2649            | 2728            | 20 |
| 21 | 75              | 43              | 13              | 83              | 53              | 25              | 97              | 70              | 44              | 19              | 95              | 72              | 50              | 29              | 21 |
| 22 | 76              | 45              | 14              | 84              | 54              | 26              | 98              | 71              | 45              | 20              | 96              | 73              | 51              | 31              | 22 |
| 23 | 77              | 46              | 15              | 85              | 56              | 27              | 99              | 72              | 46              | 21              | 98              | 75              | 53              | 32              | 23 |
| 24 | 78              | 47              | 16              | 86              | 57              | 28              | 2200            | 74              | 48              | 23              | 99              | 76              | 54              | 33              | 24 |
| 25 | 80              | 48              | 17              | 87              | 58              | 29              | 02              | 75              | 49              | 24              | 2500            | 77              | 55              | 35              | 25 |
| 26 | 81              | 49              | 18              | 88              | 59              | 31              | 03              | 76              | 50              | 25              | 01              | 78              | 57              | 36              | 26 |
| 27 | 82              | 50              | 20              | 90              | 60              | 32              | 04              | 77              | 51              | 27              | 03              | 80              | 58              | 37              | 27 |
| 28 | 83              | 52              | 21              | 91              | 61              | 33              | 05              | 79              | 53              | 28              | 04              | 81              | 59              | 39              | 28 |
| 29 | 84              | 53              | 22              | 92              | 63              | 34              | 07              | 80              | 54              | 29              | 05              | 82              | 61              | 40              | 29 |
| 30 | 1785            | 1854            | 1923            | 1993            | 2064            | 2135            | 2208            | 2281            | 2355            | 2430            | 2506            | 2584            | 2662            | 2742            | 30 |
| 31 | 86              | 55              | 24              | 94              | 65              | 37              | 09              | 82              | 56              | 32              | 08              | 85              | 63              | 43              | 31 |
| 32 | 87              | 56              | 25              | 95              | 66              | 38              | 10              | 83              | 58              | 33              | 09              | 86              | 65              | 44              | 32 |
| 33 | 89              | 57              | 27              | 97              | 67              | 39              | 11              | 85              | 59              | 34              | 10              | 88              | 66              | 46              | 33 |
| 34 | 90              | 58              | 28              | 98              | 69              | 40              | 13              | 86              | 60              | 35              | 12              | 89              | 67              | 47              | 34 |
| 35 | 91              | 60              | 29              | 99              | 70              | 41              | 14              | 87              | 61              | 37              | 13              | 90              | 69              | 48              | 35 |
| 36 | 92              | 61              | 30              | 2000            | 71              | 43              | 15              | 88              | 63              | 38              | 14              | 91              | 70              | 50              | 36 |
| 37 | 93              | 62              | 31              | 01              | 72              | 44              | 16              | 90              | 64              | 39              | 15              | 93              | 71              | 51              | 37 |
| 38 | 94              | 63              | 32              | 02              | 73              | 45              | 17              | 91              | 65              | 40              | 17              | 94              | 73              | 52              | 38 |
| 39 | 96              | 64              | 34              | 04              | 75              | 46              | 19              | 92              | 66              | 42              | 18              | 95              | 74              | 54              | 39 |
| 40 | 1797            | 1865            | 1935            | 2005            | 2076            | 2147            | 2220            | 2293            | 2368            | 2443            | 2519            | 2597            | 2675            | 2755            | 40 |
| 41 | 98              | 66              | 36              | 06              | 77              | 49              | 21              | 95              | 69              | 44              | 21              | 98              | 76              | 56              | 41 |
| 42 | 99              | 68              | 37              | 07              | 78              | 50              | 22              | 96              | 70              | 45              | 22              | 99              | 78              | 58              | 42 |
| 43 | 1800            | 69              | 38              | 08              | 79              | 51              | 24              | 97              | 71              | 47              | 23              | 2601            | 79              | 59              | 43 |
| 44 | 01              | 70              | 39              | 10              | 80              | 52              | 25              | 98              | 73              | 48              | 24              | 02              | 80              | 60              | 44 |
| 45 | 02              | 71              | 41              | 11              | 82              | 53              | 26              | 99              | 74              | 49              | 26              | 03              | 82              | 62              | 45 |
| 46 | 03              | 72              | 42              | 12              | 83              | 55              | 27              | 2301            | 75              | 51              | 27              | 04              | 83              | 63              | 46 |
| 47 | 05              | 73              | 43              | 13              | 84              | 56              | 28              | 02              | 76              | 52              | 28              | 06              | 84              | 64              | 47 |
| 48 | 06              | 75              | 44              | 14              | 85              | 57              | 30              | 03              | 78              | 53              | 30              | 07              | 86              | 66              | 48 |
| 49 | 07              | 76              | 45              | 15              | 86              | 58              | 31              | 04              | 79              | 54              | 31              | 08              | 87              | 67              | 49 |
| 50 | 1808            | 1877            | 1946            | 2017            | 2088            | 2159            | 2232            | 2306            | 2380            | 2456            | 2532            | 2610            | 2688            | 2768            | 50 |
| 51 | 09              | 78              | 48              | 18              | 89              | 61              | 33              | 07              | 81              | 57              | 33              | 11              | 90              | 70              | 51 |
| 52 | 10              | 79              | 49              | 19              | 90              | 62              | 35              | 08              | 83              | 58              | 35              | 12              | 91              | 71              | 52 |
| 53 | 11              | 80              | 50              | 20              | 91              | 63              | 36              | 09              | 84              | 59              | 36              | 14              | 92              | 72              | 53 |
| 54 | 13              | 81              | 51              | 21              | 92              | 64              | 37              | 11              | 85              | 61              | 37              | 15              | 94              | 74              | 54 |
| 55 | 14              | 83              | 52              | 22              | 94              | 65              | 38              | 12              | 86              | 62              | 38              | 16              | 95              | 75              | 55 |
| 56 | 15              | 84              | 53              | 24              | 95              | 67              | 39              | 13              | 88              | 63              | 40              | 17              | 96              | 76              | 56 |
| 57 | 16              | 85              | 55              | 25              | 96              | 68              | 41              | 14              | 89              | 64              | 41              | 19              | 98              | 78              | 57 |
| 58 | 17              | 86              | 56              | 26              | 97              | 69              | 42              | 16              | 90              | 66              | 42              | 20              | 99              | 79              | 58 |
| 59 | 18              | 87              | 57              | 27              | 98              | 70              | 43              | 17              | 91              | 67              | 44              | 21              | 2700            | 80              | 59 |

TABLE I. MERIDIONAL PARTS.

| M  | 42 <sup>d</sup> | 43 <sup>d</sup> | 44 <sup>d</sup> | 45 <sup>d</sup> | 46 <sup>d</sup> | 47 <sup>d</sup> | 48 <sup>d</sup> | 49 <sup>d</sup> | 50 <sup>d</sup> | 51 <sup>d</sup> | 52 <sup>d</sup> | 53 <sup>d</sup> | 54 <sup>d</sup> | 55 <sup>d</sup> | M  |
|----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----|
| 0  | 2782            | 2863            | 2946            | 3030            | 3116            | 3203            | 3292            | 3382            | 3474            | 3569            | 3665            | 3764            | 3865            | 3968            | 0  |
| 1  | 83              | 64              | 47              | 31              | 17              | 04              | 93              | 84              | 76              | 70              | 67              | 65              | 66              | 70              | 1  |
| 2  | 84              | 66              | 49              | 33              | 18              | 06              | 95              | 85              | 78              | 72              | 68              | 67              | 68              | 71              | 2  |
| 3  | 86              | 67              | 50              | 34              | 20              | 07              | 96              | 87              | 79              | 74              | 70              | 69              | 70              | 73              | 3  |
| 4  | 87              | 69              | 51              | 36              | 21              | 09              | 98              | 88              | 81              | 75              | 72              | 70              | 71              | 75              | 4  |
| 5  | 88              | 70              | 53              | 37              | 23              | 10              | 99              | 90              | 82              | 77              | 73              | 72              | 73              | 77              | 5  |
| 6  | 90              | 71              | 54              | 38              | 24              | 12              | 3301            | 91              | 84              | 78              | 75              | 74              | 75              | 78              | 6  |
| 7  | 91              | 73              | 56              | 40              | 26              | 13              | 02              | 93              | 85              | 80              | 77              | 75              | 77              | 80              | 7  |
| 8  | 92              | 74              | 57              | 41              | 27              | 14              | 03              | 94              | 87              | 82              | 78              | 77              | 78              | 82              | 8  |
| 9  | 94              | 75              | 58              | 43              | 29              | 16              | 05              | 96              | 88              | 83              | 80              | 79              | 80              | 84              | 9  |
| 10 | 2795            | 2877            | 2960            | 3044            | 3130            | 3217            | 3306            | 3397            | 3490            | 3585            | 3681            | 3780            | 3882            | 3985            | 10 |
| 11 | 97              | 78              | 61              | 46              | 31              | 19              | 08              | 99              | 92              | 86              | 83              | 82              | 83              | 87              | 11 |
| 12 | 98              | 80              | 63              | 47              | 33              | 20              | 09              | 3400            | 93              | 88              | 85              | 84              | 85              | 89              | 12 |
| 13 | 99              | 81              | 64              | 48              | 34              | 22              | 11              | 02              | 95              | 90              | 86              | 85              | 87              | 91              | 13 |
| 14 | 2801            | 82              | 65              | 50              | 36              | 23              | 12              | 03              | 96              | 91              | 88              | 87              | 89              | 92              | 14 |
| 15 | 02              | 84              | 67              | 51              | 37              | 25              | 14              | 05              | 98              | 93              | 90              | 88              | 90              | 94              | 15 |
| 16 | 03              | 85              | 68              | 53              | 39              | 26              | 16              | 07              | 99              | 94              | 91              | 90              | 92              | 96              | 16 |
| 17 | 05              | 86              | 70              | 54              | 40              | 28              | 17              | 08              | 3501            | 96              | 93              | 91              | 94              | 98              | 17 |
| 18 | 06              | 88              | 71              | 55              | 42              | 29              | 19              | 10              | 03              | 98              | 95              | 94              | 95              | 99              | 18 |
| 19 | 07              | 89              | 72              | 57              | 43              | 31              | 20              | 11              | 04              | 99              | 96              | 95              | 97              | 1001            | 19 |
| 20 | 2809            | 2891            | 2974            | 3058            | 3144            | 3232            | 3322            | 3413            | 3506            | 3601            | 3698            | 3797            | 3899            | 4003            | 20 |
| 21 | 10              | 92              | 75              | 60              | 46              | 34              | 23              | 14              | 07              | 02              | 99              | 99              | 3901            | 05              | 21 |
| 22 | 11              | 93              | 76              | 61              | 47              | 35              | 25              | 16              | 09              | 04              | 3701            | 3800            | 02              | 06              | 22 |
| 23 | 13              | 95              | 78              | 63              | 49              | 37              | 26              | 17              | 10              | 06              | 03              | 02              | 04              | 08              | 23 |
| 24 | 14              | 96              | 79              | 64              | 50              | 38              | 28              | 19              | 12              | 07              | 04              | 04              | 06              | 10              | 24 |
| 25 | 15              | 97              | 81              | 65              | 52              | 40              | 29              | 20              | 14              | 09              | 06              | 05              | 07              | 12              | 25 |
| 26 | 17              | 99              | 82              | 67              | 53              | 41              | 31              | 22              | 15              | 10              | 08              | 07              | 09              | 14              | 26 |
| 27 | 18              | 2900            | 83              | 68              | 55              | 42              | 32              | 23              | 17              | 12              | 09              | 09              | 11              | 15              | 27 |
| 28 | 20              | 01              | 85              | 70              | 56              | 44              | 34              | 25              | 18              | 14              | 11              | 11              | 13              | 17              | 28 |
| 29 | 21              | 03              | 86              | 71              | 57              | 45              | 35              | 27              | 20              | 15              | 13              | 12              | 14              | 19              | 29 |
| 30 | 2822            | 2904            | 2988            | 3073            | 3159            | 3247            | 3337            | 3428            | 3521            | 3617            | 3714            | 3814            | 3916            | 4021            | 30 |
| 31 | 24              | 06              | 89              | 74              | 60              | 48              | 38              | 30              | 23              | 18              | 16              | 16              | 18              | 22              | 31 |
| 32 | 25              | 07              | 91              | 75              | 62              | 50              | 40              | 31              | 25              | 20              | 17              | 17              | 19              | 24              | 32 |
| 33 | 26              | 08              | 92              | 77              | 63              | 51              | 41              | 33              | 26              | 22              | 19              | 19              | 21              | 26              | 33 |
| 34 | 28              | 10              | 93              | 78              | 65              | 53              | 43              | 34              | 28              | 23              | 21              | 21              | 23              | 28              | 34 |
| 35 | 29              | 11              | 95              | 80              | 66              | 54              | 44              | 36              | 29              | 25              | 22              | 22              | 25              | 29              | 35 |
| 36 | 30              | 13              | 96              | 81              | 68              | 56              | 46              | 37              | 31              | 26              | 24              | 24              | 26              | 31              | 36 |
| 37 | 32              | 14              | 98              | 83              | 69              | 57              | 47              | 39              | 32              | 28              | 26              | 26              | 28              | 33              | 37 |
| 38 | 33              | 15              | 99              | 84              | 71              | 59              | 49              | 40              | 34              | 30              | 27              | 27              | 30              | 35              | 38 |
| 39 | 34              | 17              | 3000            | 85              | 72              | 60              | 50              | 42              | 36              | 31              | 29              | 29              | 32              | 37              | 39 |
| 40 | 2836            | 2918            | 3002            | 3087            | 3173            | 3262            | 3352            | 3443            | 3537            | 3633            | 3731            | 3831            | 3933            | 4038            | 40 |
| 41 | 37              | 19              | 03              | 88              | 75              | 63              | 53              | 45              | 39              | 34              | 32              | 32              | 35              | 40              | 41 |
| 42 | 39              | 21              | 05              | 90              | 76              | 65              | 55              | 47              | 40              | 36              | 34              | 34              | 37              | 42              | 42 |
| 43 | 40              | 22              | 06              | 91              | 78              | 66              | 56              | 48              | 42              | 38              | 36              | 36              | 38              | 44              | 43 |
| 44 | 41              | 24              | 07              | 93              | 79              | 68              | 58              | 50              | 43              | 39              | 37              | 38              | 40              | 45              | 44 |
| 45 | 43              | 25              | 09              | 94              | 81              | 69              | 59              | 51              | 45              | 41              | 39              | 39              | 42              | 47              | 45 |
| 46 | 44              | 26              | 10              | 95              | 82              | 71              | 61              | 53              | 47              | 43              | 41              | 41              | 44              | 49              | 46 |
| 47 | 45              | 28              | 12              | 97              | 84              | 72              | 62              | 54              | 48              | 44              | 42              | 43              | 45              | 51              | 47 |
| 48 | 47              | 29              | 13              | 98              | 85              | 74              | 64              | 56              | 50              | 46              | 44              | 44              | 47              | 52              | 48 |
| 49 | 48              | 31              | 14              | 3100            | 87              | 75              | 65              | 57              | 51              | 47              | 46              | 46              | 49              | 54              | 49 |
| 50 | 2849            | 2932            | 3016            | 3101            | 3188            | 3277            | 3367            | 3459            | 3553            | 3649            | 3747            | 3848            | 3951            | 4056            | 50 |
| 51 | 51              | 33              | 17              | 03              | 90              | 78              | 68              | 60              | 55              | 51              | 49              | 49              | 52              | 58              | 51 |
| 52 | 52              | 35              | 19              | 04              | 91              | 80              | 70              | 62              | 56              | 52              | 50              | 51              | 54              | 60              | 52 |
| 53 | 54              | 36              | 20              | 06              | 92              | 81              | 71              | 64              | 58              | 54              | 52              | 53              | 56              | 61              | 53 |
| 54 | 55              | 37              | 21              | 07              | 94              | 83              | 73              | 65              | 59              | 55              | 54              | 55              | 58              | 63              | 54 |
| 55 | 56              | 39              | 23              | 08              | 95              | 84              | 74              | 67              | 61              | 57              | 55              | 56              | 59              | 65              | 55 |
| 56 | 58              | 40              | 24              | 10              | 97              | 86              | 76              | 68              | 62              | 59              | 57              | 58              | 61              | 67              | 56 |
| 57 | 59              | 42              | 26              | 11              | 98              | 87              | 78              | 70              | 64              | 60              | 59              | 60              | 63              | 69              | 57 |
| 58 | 60              | 43              | 27              | 13              | 3200            | 89              | 79              | 71              | 66              | 62              | 60              | 61              | 64              | 70              | 58 |
| 59 | 62              | 44              | 28              | 14              | 01              | 90              | 81              | 73              | 67              | 64              | 62              | 63              | 66              | 72              | 59 |



TABLE I. MERIDIONAL PARTS.

| M  | 56 <sup>d</sup> | 57 <sup>d</sup> | 58 <sup>d</sup> | 59 <sup>d</sup> | 60 <sup>d</sup> | 61 <sup>d</sup> | 62 <sup>d</sup> | 63 <sup>d</sup> | 64 <sup>d</sup> | 65 <sup>d</sup> | 66 <sup>d</sup> | 67 <sup>d</sup> | 68 <sup>d</sup> | 69 <sup>d</sup> | M  |
|----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----|
| 0  | 4074            | 4183            | 4294            | 4409            | 4527            | 4649            | 4775            | 4905            | 5039            | 5179            | 5324            | 5474            | 5631            | 5795            | 0  |
| 1  | 76              | 84              | 96              | 11              | 29              | 51              | 77              | 07              | 42              | 81              | 26              | 77              | 33              | 97              | 1  |
| 2  | 78              | 86              | 98              | 13              | 31              | 53              | 79              | 09              | 44              | 84              | 28              | 79              | 36              | 5800            | 2  |
| 3  | 79              | 88              | 1300            | 15              | 33              | 55              | 81              | 12              | 46              | 86              | 31              | 82              | 39              | 03              | 3  |
| 4  | 81              | 90              | 02              | 17              | 35              | 57              | 84              | 14              | 49              | 88              | 33              | 84              | 41              | 06              | 4  |
| 5  | 83              | 92              | 04              | 19              | 37              | 60              | 86              | 16              | 52              | 91              | 36              | 87              | 44              | 09              | 5  |
| 6  | 85              | 94              | 06              | 21              | 39              | 62              | 88              | 18              | 53              | 93              | 38              | 89              | 47              | 11              | 6  |
| 7  | 86              | 95              | 08              | 23              | 41              | 64              | 90              | 20              | 55              | 95              | 41              | 92              | 50              | 14              | 7  |
| 8  | 88              | 97              | 09              | 25              | 43              | 66              | 92              | 23              | 58              | 98              | 43              | 95              | 52              | 17              | 8  |
| 9  | 90              | 99              | 11              | 27              | 45              | 68              | 94              | 25              | 60              | 5200            | 46              | 97              | 55              | 20              | 9  |
| 10 | 4092            | 4201            | 4313            | 4429            | 4547            | 4670            | 4796            | 4927            | 5062            | 5203            | 5348            | 5500            | 5658            | 5823            | 10 |
| 11 | 94              | 03              | 15              | 31              | 49              | 72              | 98              | 29              | 65              | 05              | 51              | 02              | 60              | 25              | 11 |
| 12 | 95              | 05              | 17              | 33              | 51              | 74              | 4801            | 31              | 67              | 07              | 53              | 05              | 63              | 28              | 12 |
| 13 | 97              | 07              | 19              | 34              | 53              | 76              | 03              | 34              | 69              | 10              | 56              | 07              | 66              | 31              | 13 |
| 14 | 99              | 08              | 21              | 36              | 55              | 78              | 05              | 36              | 71              | 12              | 58              | 10              | 68              | 34              | 14 |
| 15 | 4101            | 10              | 23              | 38              | 57              | 80              | 07              | 38              | 74              | 14              | 61              | 13              | 71              | 37              | 15 |
| 16 | 03              | 12              | 25              | 40              | 59              | 82              | 09              | 40              | 76              | 17              | 63              | 15              | 74              | 39              | 16 |
| 17 | 04              | 14              | 27              | 42              | 61              | 84              | 11              | 43              | 78              | 19              | 66              | 18              | 76              | 42              | 17 |
| 18 | 06              | 16              | 28              | 44              | 64              | 87              | 14              | 45              | 81              | 22              | 68              | 20              | 79              | 45              | 18 |
| 19 | 08              | 18              | 30              | 46              | 66              | 89              | 16              | 47              | 83              | 24              | 71              | 23              | 82              | 48              | 19 |
| 20 | 4110            | 4220            | 4332            | 4448            | 4568            | 4691            | 4818            | 4949            | 5085            | 5226            | 5373            | 5526            | 5685            | 5851            | 20 |
| 21 | 12              | 21              | 34              | 50              | 70              | 93              | 20              | 51              | 88              | 29              | 76              | 28              | 87              | 54              | 21 |
| 22 | 13              | 23              | 36              | 52              | 72              | 95              | 22              | 54              | 90              | 31              | 78              | 31              | 90              | 56              | 22 |
| 23 | 15              | 25              | 38              | 54              | 74              | 97              | 24              | 56              | 92              | 34              | 80              | 33              | 93              | 59              | 23 |
| 24 | 17              | 27              | 40              | 56              | 76              | 99              | 26              | 58              | 95              | 36              | 83              | 36              | 95              | 62              | 24 |
| 25 | 19              | 29              | 42              | 58              | 78              | 4701            | 29              | 60              | 97              | 38              | 85              | 39              | 98              | 65              | 25 |
| 26 | 21              | 31              | 44              | 60              | 80              | 03              | 31              | 63              | 99              | 41              | 88              | 41              | 5701            | 68              | 26 |
| 27 | 22              | 32              | 46              | 62              | 82              | 05              | 33              | 65              | 5102            | 43              | 90              | 44              | 04              | 71              | 27 |
| 28 | 24              | 34              | 47              | 64              | 84              | 07              | 35              | 67              | 04              | 46              | 93              | 46              | 06              | 74              | 28 |
| 29 | 26              | 36              | 49              | 66              | 86              | 10              | 37              | 69              | 06              | 48              | 95              | 49              | 09              | 76              | 29 |
| 30 | 4128            | 4238            | 4351            | 4468            | 4588            | 4712            | 4839            | 4972            | 5108            | 5250            | 5398            | 5552            | 5712            | 5879            | 30 |
| 31 | 30              | 40              | 53              | 70              | 90              | 14              | 42              | 73              | 11              | 53              | 5401            | 54              | 15              | 82              | 31 |
| 32 | 32              | 42              | 55              | 72              | 92              | 16              | 44              | 76              | 13              | 55              | 03              | 57              | 17              | 85              | 32 |
| 33 | 33              | 44              | 57              | 74              | 94              | 18              | 46              | 78              | 15              | 58              | 06              | 59              | 20              | 88              | 33 |
| 34 | 35              | 46              | 59              | 76              | 96              | 20              | 48              | 81              | 18              | 60              | 08              | 62              | 23              | 91              | 34 |
| 35 | 37              | 47              | 61              | 78              | 98              | 22              | 50              | 83              | 20              | 63              | 11              | 65              | 25              | 94              | 35 |
| 36 | 39              | 49              | 63              | 80              | 4600            | 24              | 52              | 85              | 22              | 65              | 13              | 67              | 28              | 96              | 36 |
| 37 | 41              | 51              | 65              | 82              | 02              | 26              | 55              | 87              | 25              | 67              | 16              | 70              | 31              | 99              | 37 |
| 38 | 42              | 53              | 67              | 84              | 04              | 28              | 57              | 90              | 27              | 70              | 18              | 73              | 34              | 5902            | 38 |
| 39 | 44              | 55              | 69              | 86              | 06              | 31              | 59              | 92              | 30              | 72              | 21              | 75              | 36              | 05              | 39 |
| 40 | 4146            | 4257            | 4370            | 4488            | 4608            | 4733            | 4861            | 4994            | 5132            | 5275            | 5423            | 5578            | 5739            | 5908            | 40 |
| 41 | 48              | 59              | 72              | 90              | 10              | 35              | 63              | 96              | 34              | 77              | 26              | 80              | 42              | 11              | 41 |
| 42 | 50              | 60              | 74              | 92              | 12              | 37              | 65              | 99              | 36              | 80              | 28              | 83              | 45              | 14              | 42 |
| 43 | 52              | 62              | 76              | 94              | 14              | 39              | 68              | 5001            | 39              | 82              | 31              | 86              | 47              | 17              | 43 |
| 44 | 53              | 64              | 78              | 95              | 16              | 41              | 70              | 03              | 41              | 84              | 33              | 88              | 50              | 19              | 44 |
| 45 | 55              | 66              | 80              | 97              | 18              | 43              | 72              | 05              | 43              | 87              | 36              | 91              | 53              | 22              | 45 |
| 46 | 57              | 68              | 82              | 99              | 20              | 45              | 74              | 08              | 46              | 89              | 38              | 94              | 56              | 25              | 46 |
| 47 | 59              | 70              | 84              | 4501            | 23              | 47              | 76              | 10              | 48              | 92              | 41              | 96              | 58              | 28              | 47 |
| 48 | 61              | 72              | 86              | 03              | 25              | 50              | 79              | 12              | 51              | 94              | 43              | 99              | 61              | 31              | 48 |
| 49 | 62              | 74              | 88              | 05              | 27              | 52              | 81              | 14              | 53              | 97              | 46              | 5602            | 64              | 34              | 49 |
| 50 | 4164            | 4275            | 4390            | 4507            | 4629            | 4754            | 4883            | 5017            | 5155            | 5299            | 5448            | 5604            | 5767            | 5937            | 50 |
| 51 | 66              | 77              | 92              | 09              | 31              | 56              | 85              | 19              | 58              | 5301            | 51              | 07              | 70              | 40              | 51 |
| 52 | 68              | 79              | 94              | 11              | 33              | 58              | 87              | 21              | 60              | 04              | 54              | 10              | 72              | 43              | 52 |
| 53 | 70              | 81              | 96              | 13              | 35              | 60              | 90              | 23              | 62              | 06              | 56              | 12              | 75              | 46              | 53 |
| 54 | 72              | 83              | 98              | 15              | 37              | 62              | 92              | 26              | 65              | 09              | 59              | 15              | 78              | 48              | 54 |
| 55 | 73              | 85              | 99              | 17              | 39              | 64              | 94              | 28              | 67              | 11              | 61              | 17              | 81              | 51              | 55 |
| 56 | 75              | 87              | 4401            | 19              | 41              | 66              | 96              | 30              | 69              | 14              | 64              | 20              | 83              | 54              | 56 |
| 57 | 77              | 89              | 03              | 21              | 43              | 69              | 98              | 33              | 72              | 16              | 66              | 23              | 86              | 57              | 57 |
| 58 | 79              | 91              | 05              | 23              | 45              | 71              | 4901            | 35              | 74              | 19              | 69              | 25              | 89              | 60              | 58 |
| 59 | 81              | 93              | 07              | 25              | 47              | 73              | 03              | 37              | 76              | 21              | 71              | 28              | 92              | 63              | 59 |

TABLE I. MERIDIONAL PARTS.

| M  | 70 <sup>d</sup> | 71 <sup>d</sup> | 72 <sup>d</sup> | 73 <sup>d</sup> | 74 <sup>d</sup> | 75 <sup>d</sup> | 76 <sup>d</sup> | 77 <sup>d</sup> | 78 <sup>d</sup> | 79 <sup>d</sup> | 80 <sup>d</sup> | 81 <sup>d</sup> | 82 <sup>d</sup> | 83 <sup>d</sup> | M  |
|----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----|
| 0  | 5966            | 6146            | 6335            | 6534            | 6746            | 6970            | 7210            | 7467            | 7745            | 8046            | 8375            | 8739            | 9145            | 9606            | 0  |
| 1  | 69              | 49              | 38              | 38              | 49              | 74              | 14              | 72              | 49              | 51              | 81              | 45              | 53              | 14              | 1  |
| 2  | 72              | 52              | 41              | 41              | 53              | 78              | 18              | 76              | 54              | 56              | 87              | 52              | 60              | 22              | 2  |
| 3  | 75              | 55              | 45              | 45              | 57              | 82              | 22              | 81              | 59              | 61              | 93              | 58              | 67              | 31              | 3  |
| 4  | 78              | 58              | 48              | 48              | 60              | 86              | 27              | 85              | 64              | 67              | 98              | 65              | 74              | 39              | 4  |
| 5  | 81              | 61              | 51              | 52              | 64              | 90              | 31              | 90              | 69              | 72              | 8404            | 71              | 82              | 47              | 5  |
| 6  | 84              | 64              | 54              | 55              | 68              | 94              | 35              | 94              | 74              | 77              | 10              | 78              | 89              | 55              | 6  |
| 7  | 86              | 67              | 58              | 58              | 71              | 97              | 39              | 98              | 78              | 83              | 16              | 84              | 96              | 64              | 7  |
| 8  | 89              | 70              | 61              | 62              | 75              | 1001            | 43              | 7503            | 83              | 88              | 22              | 91              | 9203            | 72              | 8  |
| 9  | 92              | 73              | 64              | 65              | 79              | 05              | 47              | 07              | 88              | 93              | 27              | 97              | 11              | 81              | 9  |
| 10 | 5995            | 6177            | 6367            | 6569            | 6782            | 7009            | 7252            | 7512            | 7793            | 8099            | 8433            | 8804            | 9218            | 9689            | 10 |
| 11 | 98              | 80              | 71              | 72              | 86              | 13              | 56              | 16              | 98              | 8104            | 39              | 10              | 25              | 97              | 11 |
| 12 | 6001            | 83              | 74              | 76              | 90              | 17              | 60              | 21              | 7803            | 09              | 45              | 17              | 33              | 9706            | 12 |
| 13 | 04              | 86              | 77              | 79              | 93              | 21              | 64              | 25              | 08              | 15              | 51              | 23              | 40              | 14              | 13 |
| 14 | 07              | 89              | 80              | 83              | 97              | 25              | 68              | 30              | 13              | 20              | 57              | 30              | 48              | 23              | 14 |
| 15 | 10              | 92              | 84              | 86              | 101             | 29              | 73              | 35              | 17              | 25              | 63              | 36              | 55              | 31              | 15 |
| 16 | 13              | 95              | 87              | 90              | 04              | 33              | 77              | 39              | 22              | 31              | 69              | 43              | 62              | 40              | 16 |
| 17 | 16              | 98              | 90              | 93              | 08              | 37              | 81              | 44              | 27              | 36              | 74              | 49              | 70              | 48              | 17 |
| 18 | 19              | 6201            | 94              | 96              | 12              | 41              | 85              | 48              | 32              | 41              | 80              | 56              | 77              | 57              | 18 |
| 19 | 22              | 05              | 97              | 6600            | 15              | 45              | 89              | 53              | 37              | 47              | 86              | 63              | 85              | 65              | 19 |
| 20 | 6025            | 6208            | 6400            | 6603            | 6819            | 7049            | 7294            | 7557            | 7842            | 8152            | 8492            | 8869            | 9292            | 9774            | 20 |
| 21 | 28              | 11              | 03              | 07              | 23              | 52              | 98              | 62              | 47              | 58              | 98              | 76              | 9300            | 83              | 21 |
| 22 | 31              | 14              | 07              | 10              | 26              | 56              | 7302            | 66              | 52              | 63              | 8504            | 83              | 07              | 91              | 22 |
| 23 | 34              | 17              | 10              | 14              | 30              | 60              | 06              | 71              | 57              | 68              | 10              | 89              | 15              | 9800            | 23 |
| 24 | 37              | 20              | 13              | 17              | 34              | 64              | 11              | 76              | 62              | 74              | 16              | 96              | 22              | 09              | 24 |
| 25 | 40              | 23              | 17              | 21              | 38              | 68              | 15              | 80              | 67              | 79              | 22              | 8903            | 30              | 17              | 25 |
| 26 | 43              | 26              | 20              | 24              | 41              | 72              | 19              | 85              | 72              | 85              | 28              | 09              | 38              | 26              | 26 |
| 27 | 46              | 30              | 23              | 28              | 45              | 76              | 23              | 89              | 77              | 90              | 34              | 16              | 45              | 35              | 27 |
| 28 | 49              | 33              | 27              | 31              | 49              | 80              | 28              | 94              | 82              | 96              | 40              | 23              | 53              | 44              | 28 |
| 29 | 52              | 36              | 30              | 35              | 53              | 84              | 32              | 98              | 87              | 8201            | 46              | 30              | 60              | 52              | 29 |
| 30 | 6055            | 6239            | 6433            | 6639            | 6856            | 7088            | 7336            | 7603            | 7892            | 8207            | 8552            | 8936            | 9368            | 9861            | 30 |
| 31 | 58              | 42              | 37              | 42              | 60              | 92              | 40              | 08              | 97              | 12              | 58              | 43              | 76              | 70              | 31 |
| 32 | 61              | 45              | 40              | 46              | 64              | 96              | 45              | 12              | 7902            | 18              | 64              | 50              | 83              | 79              | 32 |
| 33 | 64              | 49              | 43              | 49              | 68              | 1000            | 49              | 17              | 07              | 23              | 71              | 57              | 91              | 88              | 33 |
| 34 | 67              | 52              | 47              | 53              | 71              | 04              | 53              | 22              | 12              | 29              | 77              | 63              | 99              | 97              | 34 |
| 35 | 70              | 55              | 50              | 56              | 75              | 08              | 58              | 26              | 17              | 34              | 83              | 70              | 9407            | 9906            | 35 |
| 36 | 73              | 58              | 53              | 60              | 79              | 12              | 62              | 31              | 22              | 40              | 89              | 77              | 14              | 15              | 36 |
| 37 | 76              | 61              | 57              | 63              | 83              | 16              | 66              | 36              | 27              | 45              | 95              | 84              | 22              | 24              | 37 |
| 38 | 79              | 64              | 60              | 67              | 86              | 20              | 71              | 40              | 32              | 51              | 8601            | 91              | 30              | 33              | 38 |
| 39 | 82              | 68              | 63              | 70              | 90              | 24              | 75              | 45              | 37              | 56              | 07              | 98              | 38              | 42              | 39 |
| 40 | 6085            | 6271            | 6467            | 6674            | 6894            | 7128            | 7379            | 7650            | 7942            | 8262            | 8614            | 9005            | 9445            | 9951            | 40 |
| 41 | 88              | 74              | 70              | 77              | 98              | 32              | 84              | 54              | 48              | 67              | 20              | 12              | 53              | 60              | 41 |
| 42 | 91              | 77              | 73              | 81              | 6901            | 36              | 88              | 59              | 53              | 73              | 26              | 18              | 61              | 69              | 42 |
| 43 | 94              | 80              | 77              | 85              | 05              | 40              | 92              | 64              | 58              | 79              | 32              | 25              | 69              | 78              | 43 |
| 44 | 97              | 83              | 80              | 88              | 09              | 45              | 97              | 68              | 63              | 84              | 38              | 32              | 77              | 87              | 44 |
| 45 | 6100            | 87              | 83              | 92              | 13              | 49              | 7401            | 73              | 68              | 90              | 44              | 39              | 85              | 9996            | 45 |
| 46 | 04              | 90              | 87              | 95              | 17              | 53              | 06              | 78              | 73              | 95              | 51              | 46              | 93              | 10005           | 46 |
| 47 | 06              | 93              | 90              | 99              | 20              | 57              | 10              | 83              | 78              | 8301            | 57              | 53              | 9501            | 10015           | 47 |
| 48 | 09              | 96              | 94              | 6702            | 24              | 61              | 14              | 87              | 83              | 07              | 63              | 60              | 09              | 10024           | 48 |
| 49 | 12              | 99              | 97              | 06              | 28              | 65              | 19              | 92              | 89              | 12              | 69              | 67              | 17              | 10033           | 49 |
| 50 | 6115            | 6303            | 6500            | 6710            | 6932            | 7169            | 7423            | 7697            | 7994            | 8218            | 8676            | 9074            | 9525            | 10043           | 50 |
| 51 | 18              | 06              | 04              | 13              | 36              | 73              | 27              | 7702            | 99              | 24              | 82              | 81              | 33              | 10052           | 51 |
| 52 | 21              | 09              | 07              | 17              | 40              | 77              | 32              | 06              | 8004            | 29              | 88              | 88              | 41              | 10061           | 52 |
| 53 | 24              | 12              | 11              | 20              | 43              | 81              | 36              | 11              | 09              | 35              | 95              | 96              | 49              | 10071           | 53 |
| 54 | 27              | 15              | 14              | 24              | 47              | 85              | 41              | 16              | 14              | 41              | 8701            | 9103            | 57              | 10080           | 54 |
| 55 | 30              | 19              | 17              | 28              | 51              | 89              | 45              | 21              | 20              | 47              | 07              | 10              | 65              | 10089           | 55 |
| 56 | 33              | 22              | 21              | 31              | 55              | 94              | 49              | 25              | 25              | 52              | 14              | 17              | 73              | 10099           | 56 |
| 57 | 36              | 25              | 24              | 35              | 59              | 98              | 54              | 30              | 30              | 58              | 20              | 24              | 81              | 10108           | 57 |
| 58 | 40              | 28              | 28              | 38              | 63              | 7202            | 58              | 35              | 35              | 64              | 26              | 31              | 89              | 10118           | 58 |
| 59 | 43              | 32              | 31              | 42              | 66              | 06              | 63              | 40              | 40              | 69              | 33              | 38              | 98              | 10127           | 59 |

TABLE II. Difference of Latitude and Departure for  $\frac{1}{4}$  Point.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.0 | 61   | 60.9  | 03.0 | 121  | 120.9 | 05.9 | 181  | 180.8 | 08.9 | 241  | 240.7 | 11.8 |
| 2    | 02.0 | 00.1 | 62   | 61.9  | 03.0 | 22   | 121.9 | 06.0 | 82   | 181.8 | 08.9 | 42   | 241.7 | 11.9 |
| 3    | 03.0 | 00.1 | 63   | 62.9  | 03.1 | 23   | 122.9 | 06.0 | 83   | 182.8 | 09.0 | 43   | 242.7 | 11.9 |
| 4    | 04.0 | 00.2 | 64   | 63.9  | 03.1 | 24   | 123.9 | 06.1 | 84   | 183.8 | 09.0 | 44   | 243.7 | 12.0 |
| 5    | 05.0 | 00.2 | 65   | 64.9  | 03.2 | 25   | 124.9 | 06.1 | 85   | 184.8 | 09.1 | 45   | 244.7 | 12.0 |
| 6    | 06.0 | 00.3 | 66   | 65.9  | 03.2 | 26   | 125.8 | 06.2 | 86   | 185.8 | 09.1 | 46   | 245.7 | 12.1 |
| 7    | 07.0 | 00.3 | 67   | 66.9  | 03.3 | 27   | 126.8 | 06.2 | 87   | 186.8 | 09.2 | 47   | 246.7 | 12.1 |
| 8    | 08.0 | 00.4 | 68   | 67.9  | 03.3 | 28   | 127.8 | 06.3 | 88   | 187.8 | 09.2 | 48   | 247.7 | 12.2 |
| 9    | 09.0 | 00.4 | 69   | 68.9  | 03.4 | 29   | 128.8 | 06.3 | 89   | 188.8 | 09.3 | 49   | 248.7 | 12.2 |
| 10   | 10.0 | 00.5 | 70   | 69.9  | 03.4 | 30   | 129.8 | 06.4 | 90   | 189.8 | 09.3 | 50   | 249.7 | 12.3 |
| 11   | 11.0 | 00.5 | 71   | 70.9  | 03.5 | 131  | 130.8 | 06.4 | 191  | 190.8 | 09.4 | 251  | 250.7 | 12.3 |
| 12   | 12.0 | 00.6 | 72   | 71.9  | 03.5 | 32   | 131.8 | 06.5 | 92   | 191.8 | 09.4 | 52   | 251.7 | 12.4 |
| 13   | 13.0 | 00.6 | 73   | 72.9  | 03.6 | 33   | 132.8 | 06.5 | 93   | 192.8 | 09.5 | 53   | 252.7 | 12.4 |
| 14   | 14.0 | 00.7 | 74   | 73.9  | 03.6 | 34   | 133.8 | 06.6 | 94   | 193.8 | 09.5 | 54   | 253.7 | 12.5 |
| 15   | 15.0 | 00.7 | 75   | 74.9  | 03.7 | 35   | 134.8 | 06.6 | 95   | 194.8 | 09.6 | 55   | 254.7 | 12.5 |
| 16   | 16.0 | 00.8 | 76   | 75.9  | 03.7 | 36   | 135.8 | 06.7 | 96   | 195.8 | 09.6 | 56   | 255.7 | 12.6 |
| 17   | 17.0 | 00.8 | 77   | 76.9  | 03.8 | 37   | 136.8 | 06.7 | 97   | 196.8 | 09.7 | 57   | 256.7 | 12.6 |
| 18   | 18.0 | 00.9 | 78   | 77.9  | 03.8 | 38   | 137.8 | 06.8 | 98   | 197.8 | 09.7 | 58   | 257.7 | 12.7 |
| 19   | 19.0 | 00.9 | 79   | 78.9  | 03.9 | 39   | 138.8 | 06.8 | 99   | 198.8 | 09.8 | 59   | 258.7 | 12.7 |
| 20   | 20.0 | 01.0 | 80   | 79.9  | 03.9 | 40   | 139.8 | 06.9 | 200  | 199.8 | 09.8 | 60   | 259.7 | 12.8 |
| 21   | 21.0 | 01.0 | 81   | 80.9  | 04.0 | 141  | 140.8 | 06.9 | 201  | 200.8 | 09.9 | 261  | 260.7 | 12.8 |
| 22   | 22.0 | 01.1 | 82   | 81.9  | 04.0 | 42   | 141.8 | 07.0 | 02   | 201.8 | 09.9 | 62   | 261.7 | 12.9 |
| 23   | 23.0 | 01.1 | 83   | 82.9  | 04.1 | 43   | 142.8 | 07.0 | 03   | 202.8 | 10.0 | 63   | 262.7 | 12.9 |
| 24   | 24.0 | 01.2 | 84   | 83.9  | 04.1 | 44   | 143.8 | 07.1 | 04   | 203.8 | 10.0 | 64   | 263.7 | 13.0 |
| 25   | 25.0 | 01.2 | 85   | 84.9  | 04.2 | 45   | 144.8 | 07.1 | 05   | 204.8 | 10.1 | 65   | 264.7 | 13.0 |
| 26   | 26.0 | 01.3 | 86   | 85.9  | 04.2 | 46   | 145.8 | 07.2 | 06   | 205.8 | 10.1 | 66   | 265.7 | 13.1 |
| 27   | 27.0 | 01.3 | 87   | 86.9  | 04.3 | 47   | 146.8 | 07.2 | 07   | 206.8 | 10.2 | 67   | 266.7 | 13.1 |
| 28   | 28.0 | 01.4 | 88   | 87.9  | 04.3 | 48   | 147.8 | 07.3 | 08   | 207.7 | 10.2 | 68   | 267.7 | 13.2 |
| 29   | 29.0 | 01.4 | 89   | 88.9  | 04.4 | 49   | 148.8 | 07.3 | 09   | 208.7 | 10.3 | 69   | 268.7 | 13.2 |
| 30   | 30.0 | 01.5 | 90   | 89.9  | 04.4 | 50   | 149.8 | 07.4 | 10   | 209.7 | 10.3 | 70   | 269.7 | 13.3 |
| 31   | 31.0 | 01.5 | 91   | 90.9  | 04.5 | 151  | 150.8 | 07.4 | 211  | 210.7 | 10.4 | 271  | 270.7 | 13.3 |
| 32   | 32.0 | 01.6 | 92   | 91.9  | 04.5 | 52   | 151.8 | 07.5 | 12   | 211.7 | 10.4 | 72   | 271.7 | 13.4 |
| 33   | 33.0 | 01.6 | 93   | 92.9  | 04.6 | 53   | 152.8 | 07.5 | 13   | 212.7 | 10.5 | 73   | 272.7 | 13.4 |
| 34   | 34.0 | 01.7 | 94   | 93.9  | 04.6 | 54   | 153.8 | 07.6 | 14   | 213.7 | 10.5 | 74   | 273.7 | 13.5 |
| 35   | 35.0 | 01.7 | 95   | 94.9  | 04.7 | 55   | 154.8 | 07.6 | 15   | 214.7 | 10.6 | 75   | 274.7 | 13.5 |
| 36   | 36.0 | 01.8 | 96   | 95.9  | 04.7 | 56   | 155.8 | 07.7 | 16   | 215.7 | 10.6 | 76   | 275.7 | 13.6 |
| 37   | 37.0 | 01.8 | 97   | 96.9  | 04.8 | 57   | 156.8 | 07.7 | 17   | 216.7 | 10.7 | 77   | 276.7 | 13.6 |
| 38   | 38.0 | 01.9 | 98   | 97.9  | 04.8 | 58   | 157.8 | 07.8 | 18   | 217.7 | 10.7 | 78   | 277.7 | 13.7 |
| 39   | 39.0 | 01.9 | 99   | 98.9  | 04.9 | 59   | 158.8 | 07.8 | 19   | 218.7 | 10.8 | 79   | 278.7 | 13.7 |
| 40   | 40.0 | 02.0 | 100  | 99.9  | 04.9 | 60   | 159.8 | 07.9 | 20   | 219.7 | 10.8 | 80   | 279.7 | 13.8 |
| 41   | 41.0 | 02.0 | 101  | 100.9 | 05.0 | 161  | 160.8 | 07.9 | 221  | 220.7 | 10.9 | 281  | 280.7 | 13.8 |
| 42   | 41.9 | 02.1 | 02   | 101.9 | 05.0 | 62   | 161.8 | 08.0 | 22   | 221.7 | 10.9 | 82   | 281.7 | 13.9 |
| 43   | 42.9 | 02.1 | 03   | 102.9 | 05.1 | 63   | 162.8 | 08.0 | 23   | 222.7 | 11.0 | 83   | 282.7 | 13.9 |
| 44   | 43.9 | 02.2 | 04   | 103.9 | 05.1 | 64   | 163.8 | 08.1 | 24   | 223.7 | 11.0 | 84   | 283.7 | 14.0 |
| 45   | 44.9 | 02.2 | 05   | 104.9 | 05.2 | 65   | 164.8 | 08.1 | 25   | 224.7 | 11.1 | 85   | 284.7 | 14.0 |
| 46   | 45.9 | 02.3 | 06   | 105.9 | 05.2 | 66   | 165.8 | 08.2 | 26   | 225.7 | 11.1 | 86   | 285.7 | 14.1 |
| 47   | 46.9 | 02.3 | 07   | 106.9 | 05.3 | 67   | 166.8 | 08.2 | 27   | 226.7 | 11.2 | 87   | 286.7 | 14.1 |
| 48   | 47.9 | 02.4 | 08   | 107.9 | 05.3 | 68   | 167.8 | 08.3 | 28   | 227.7 | 11.2 | 88   | 287.7 | 14.2 |
| 49   | 48.9 | 02.4 | 09   | 108.9 | 05.4 | 69   | 168.8 | 08.3 | 29   | 228.7 | 11.3 | 89   | 288.7 | 14.2 |
| 50   | 49.9 | 02.5 | 10   | 109.9 | 05.4 | 70   | 169.8 | 08.4 | 30   | 229.7 | 11.3 | 90   | 289.7 | 14.3 |
| 51   | 50.9 | 02.5 | 111  | 110.9 | 05.5 | 171  | 170.8 | 08.4 | 231  | 230.7 | 11.4 | 291  | 290.7 | 14.3 |
| 52   | 51.9 | 02.6 | 12   | 111.9 | 05.5 | 72   | 171.8 | 08.5 | 32   | 231.7 | 11.4 | 92   | 291.6 | 14.4 |
| 53   | 52.9 | 02.6 | 13   | 112.9 | 05.5 | 73   | 172.8 | 08.5 | 33   | 232.7 | 11.5 | 93   | 292.6 | 14.4 |
| 54   | 53.9 | 02.7 | 14   | 113.9 | 05.6 | 74   | 173.8 | 08.5 | 34   | 233.7 | 11.5 | 94   | 293.6 | 14.5 |
| 55   | 54.9 | 02.7 | 15   | 114.9 | 05.6 | 75   | 174.8 | 08.6 | 35   | 234.7 | 11.5 | 95   | 294.6 | 14.5 |
| 56   | 55.9 | 02.8 | 16   | 115.9 | 05.7 | 76   | 175.8 | 08.6 | 36   | 235.7 | 11.6 | 96   | 295.6 | 14.5 |
| 57   | 56.9 | 02.8 | 17   | 116.9 | 05.7 | 77   | 176.8 | 08.7 | 37   | 236.7 | 11.6 | 97   | 296.6 | 14.6 |
| 58   | 57.9 | 02.9 | 18   | 117.9 | 05.8 | 78   | 177.8 | 08.7 | 38   | 237.7 | 11.7 | 98   | 297.6 | 14.6 |
| 59   | 58.9 | 02.9 | 19   | 118.9 | 05.8 | 79   | 178.8 | 08.8 | 39   | 238.7 | 11.7 | 99   | 298.6 | 14.7 |
| 60   | 59.9 | 02.9 | 20   | 119.9 | 05.9 | 80   | 179.8 | 08.8 | 40   | 239.7 | 11.8 | 300  | 299.6 | 14.7 |
| Dist | Dep. | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat  |

for  $7\frac{3}{4}$  Points.



TABLE II. Difference of Latitude and Departure for 1 Point.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.1 | 61   | 60.7  | 06.0 | 121  | 126.4 | 11.8 | 181  | 186.1 | 17.7 | 241  | 239.8 | 21.9 |
| 2    | 02.0 | 00.2 | 62   | 61.7  | 06.1 | 22   | 121.4 | 11.9 | 82   | 181.1 | 17.8 | 42   | 240.8 | 22.0 |
| 3    | 03.0 | 00.3 | 63   | 62.7  | 06.2 | 23   | 122.4 | 12.0 | 83   | 182.1 | 17.9 | 43   | 241.8 | 22.1 |
| 4    | 04.0 | 00.4 | 64   | 63.7  | 06.3 | 24   | 123.4 | 12.1 | 84   | 183.1 | 18.0 | 44   | 242.8 | 22.2 |
| 5    | 05.0 | 00.5 | 65   | 64.7  | 06.4 | 25   | 124.4 | 12.2 | 85   | 184.1 | 18.1 | 45   | 243.8 | 22.3 |
| 6    | 06.0 | 00.6 | 66   | 65.7  | 06.5 | 26   | 125.4 | 12.3 | 86   | 185.1 | 18.2 | 46   | 244.8 | 22.4 |
| 7    | 07.0 | 00.7 | 67   | 66.7  | 06.6 | 27   | 126.4 | 12.4 | 87   | 186.1 | 18.3 | 47   | 245.8 | 22.5 |
| 8    | 08.0 | 00.8 | 68   | 67.7  | 06.7 | 28   | 127.4 | 12.5 | 88   | 187.1 | 18.4 | 48   | 246.8 | 22.6 |
| 9    | 09.0 | 00.9 | 69   | 68.7  | 06.7 | 29   | 128.4 | 12.6 | 89   | 188.1 | 18.5 | 49   | 247.8 | 22.7 |
| 10   | 10.0 | 01.0 | 70   | 69.7  | 06.8 | 30   | 129.4 | 12.7 | 90   | 189.1 | 18.6 | 50   | 248.8 | 22.8 |
| 11   | 10.9 | 01.1 | 71   | 70.7  | 06.9 | 131  | 130.4 | 12.8 | 191  | 190.1 | 18.7 | 251  | 249.8 | 22.9 |
| 12   | 11.9 | 01.2 | 72   | 71.7  | 07.0 | 32   | 131.4 | 12.9 | 92   | 191.1 | 18.8 | 52   | 250.8 | 23.0 |
| 13   | 12.9 | 01.3 | 73   | 72.6  | 07.1 | 33   | 132.4 | 13.0 | 93   | 192.1 | 18.9 | 53   | 251.8 | 23.1 |
| 14   | 13.9 | 01.4 | 74   | 73.6  | 07.2 | 34   | 133.4 | 13.1 | 94   | 193.1 | 19.0 | 54   | 252.8 | 23.2 |
| 15   | 14.9 | 01.5 | 75   | 74.6  | 07.3 | 35   | 134.4 | 13.2 | 95   | 194.1 | 19.1 | 55   | 253.8 | 23.3 |
| 16   | 15.9 | 01.6 | 76   | 75.6  | 07.4 | 36   | 135.3 | 13.3 | 96   | 195.1 | 19.2 | 56   | 254.8 | 23.4 |
| 17   | 16.9 | 01.7 | 77   | 76.6  | 07.5 | 37   | 136.3 | 13.4 | 97   | 196.1 | 19.3 | 57   | 255.8 | 23.5 |
| 18   | 17.9 | 01.8 | 78   | 77.6  | 07.6 | 38   | 137.3 | 13.5 | 98   | 197.0 | 19.4 | 58   | 256.8 | 23.6 |
| 19   | 18.9 | 01.9 | 79   | 78.6  | 07.7 | 39   | 138.3 | 13.6 | 99   | 198.0 | 19.5 | 59   | 257.8 | 23.7 |
| 20   | 19.9 | 02.0 | 80   | 79.6  | 07.8 | 40   | 139.3 | 13.7 | 200  | 199.0 | 19.6 | 60   | 258.8 | 23.8 |
| 21   | 20.9 | 02.1 | 81   | 80.6  | 07.9 | 141  | 140.3 | 13.8 | 201  | 200.0 | 19.7 | 261  | 259.7 | 23.9 |
| 22   | 21.9 | 02.2 | 82   | 81.6  | 08.0 | 42   | 141.3 | 13.9 | 02   | 201.0 | 19.8 | 62   | 260.7 | 24.0 |
| 23   | 22.9 | 02.2 | 83   | 82.6  | 08.1 | 43   | 142.3 | 14.0 | 03   | 202.0 | 19.9 | 63   | 261.7 | 24.1 |
| 24   | 23.9 | 02.3 | 84   | 83.6  | 08.2 | 44   | 143.3 | 14.1 | 04   | 203.0 | 20.0 | 64   | 262.7 | 24.2 |
| 25   | 24.9 | 02.4 | 85   | 84.6  | 08.3 | 45   | 144.3 | 14.2 | 05   | 204.0 | 20.1 | 65   | 263.7 | 24.3 |
| 26   | 25.9 | 02.5 | 86   | 85.6  | 08.4 | 46   | 145.3 | 14.3 | 06   | 205.0 | 20.2 | 66   | 264.7 | 24.4 |
| 27   | 26.9 | 02.6 | 87   | 86.6  | 08.5 | 47   | 146.3 | 14.4 | 07   | 206.0 | 20.2 | 67   | 265.7 | 24.5 |
| 28   | 27.9 | 02.7 | 88   | 87.6  | 08.6 | 48   | 147.3 | 14.5 | 08   | 207.0 | 20.3 | 68   | 266.7 | 24.6 |
| 29   | 28.9 | 02.8 | 89   | 88.6  | 08.7 | 49   | 148.3 | 14.6 | 09   | 208.0 | 20.4 | 69   | 267.7 | 24.7 |
| 30   | 29.9 | 02.9 | 90   | 89.6  | 08.8 | 50   | 149.3 | 14.7 | 10   | 209.0 | 20.5 | 70   | 268.7 | 24.8 |
| 31   | 30.9 | 03.0 | 91   | 90.6  | 08.9 | 151  | 150.3 | 14.8 | 211  | 210.0 | 20.6 | 271  | 269.7 | 24.9 |
| 32   | 31.8 | 03.1 | 92   | 91.6  | 09.0 | 52   | 151.3 | 14.9 | 12   | 211.0 | 20.7 | 72   | 270.7 | 25.0 |
| 33   | 32.8 | 03.2 | 93   | 92.6  | 09.1 | 53   | 152.3 | 15.0 | 13   | 212.0 | 20.8 | 73   | 271.7 | 25.1 |
| 34   | 33.8 | 03.3 | 94   | 93.5  | 09.2 | 54   | 153.3 | 15.1 | 14   | 213.0 | 20.9 | 74   | 272.7 | 25.2 |
| 35   | 34.8 | 03.4 | 95   | 94.5  | 09.3 | 55   | 154.3 | 15.2 | 15   | 214.0 | 21.0 | 75   | 273.7 | 25.3 |
| 36   | 35.8 | 03.5 | 96   | 95.5  | 09.4 | 56   | 155.3 | 15.3 | 16   | 215.0 | 21.1 | 76   | 274.7 | 25.4 |
| 37   | 36.8 | 03.6 | 97   | 96.5  | 09.5 | 57   | 156.2 | 15.4 | 17   | 216.0 | 21.2 | 77   | 275.7 | 25.5 |
| 38   | 37.8 | 03.7 | 98   | 97.5  | 09.6 | 58   | 157.2 | 15.5 | 18   | 217.0 | 21.3 | 78   | 276.7 | 25.6 |
| 39   | 38.8 | 03.8 | 99   | 98.5  | 09.7 | 59   | 158.2 | 15.6 | 19   | 217.9 | 21.4 | 79   | 277.7 | 25.7 |
| 40   | 39.8 | 03.9 | 100  | 99.5  | 09.8 | 60   | 159.2 | 15.7 | 20   | 218.9 | 21.5 | 80   | 278.7 | 25.8 |
| 41   | 40.8 | 04.0 | 101  | 100.5 | 09.9 | 161  | 160.2 | 15.7 | 221  | 219.9 | 21.6 | 281  | 279.6 | 25.9 |
| 42   | 41.8 | 04.1 | 02   | 101.5 | 10.0 | 62   | 161.2 | 15.8 | 22   | 220.9 | 21.7 | 82   | 280.6 | 26.0 |
| 43   | 42.8 | 04.2 | 03   | 102.5 | 10.1 | 63   | 162.2 | 15.9 | 23   | 221.9 | 21.8 | 83   | 281.6 | 26.1 |
| 44   | 43.8 | 04.3 | 04   | 103.5 | 10.2 | 64   | 163.2 | 16.0 | 24   | 222.9 | 21.9 | 84   | 282.6 | 26.2 |
| 45   | 44.8 | 04.4 | 05   | 104.5 | 10.3 | 65   | 164.2 | 16.1 | 25   | 223.9 | 22.0 | 85   | 283.6 | 26.3 |
| 46   | 45.8 | 04.5 | 06   | 105.5 | 10.4 | 66   | 165.2 | 16.2 | 26   | 224.9 | 22.1 | 86   | 284.6 | 26.4 |
| 47   | 46.8 | 04.6 | 07   | 106.5 | 10.5 | 67   | 166.2 | 16.3 | 27   | 225.9 | 22.2 | 87   | 285.6 | 26.5 |
| 48   | 47.8 | 04.7 | 08   | 107.5 | 10.6 | 68   | 167.2 | 16.4 | 28   | 226.9 | 22.3 | 88   | 286.6 | 26.6 |
| 49   | 48.8 | 04.8 | 09   | 108.5 | 10.7 | 69   | 168.2 | 16.5 | 29   | 227.9 | 22.4 | 89   | 287.6 | 26.7 |
| 50   | 49.8 | 04.9 | 10   | 109.5 | 10.8 | 70   | 169.2 | 16.6 | 30   | 228.9 | 22.5 | 90   | 288.6 | 26.8 |
| 51   | 50.8 | 05.0 | 111  | 110.5 | 10.9 | 171  | 170.2 | 16.7 | 231  | 229.9 | 22.6 | 291  | 289.6 | 26.9 |
| 52   | 51.8 | 05.1 | 12   | 111.5 | 11.0 | 72   | 171.2 | 16.8 | 32   | 230.9 | 22.7 | 92   | 290.6 | 27.0 |
| 53   | 52.7 | 05.2 | 13   | 112.5 | 11.1 | 73   | 172.2 | 16.9 | 33   | 231.9 | 22.8 | 93   | 291.6 | 27.1 |
| 54   | 53.7 | 05.3 | 14   | 113.5 | 11.2 | 74   | 173.2 | 17.0 | 34   | 232.9 | 22.9 | 94   | 292.6 | 27.2 |
| 55   | 54.7 | 05.4 | 15   | 114.4 | 11.2 | 75   | 174.2 | 17.1 | 35   | 233.9 | 23.0 | 95   | 293.6 | 27.3 |
| 56   | 55.7 | 05.5 | 16   | 115.4 | 11.3 | 76   | 175.2 | 17.2 | 36   | 234.9 | 23.1 | 96   | 294.6 | 27.4 |
| 57   | 56.7 | 05.6 | 17   | 116.4 | 11.4 | 77   | 176.2 | 17.3 | 37   | 235.9 | 23.2 | 97   | 295.6 | 27.5 |
| 58   | 57.7 | 05.7 | 18   | 117.4 | 11.5 | 79   | 177.1 | 17.4 | 38   | 236.9 | 23.3 | 98   | 296.6 | 27.6 |
| 59   | 58.7 | 05.8 | 19   | 118.4 | 11.6 | 79   | 178.1 | 17.5 | 39   | 237.9 | 23.4 | 99   | 297.6 | 27.7 |
| 60   | 59.7 | 05.9 | 20   | 119.4 | 11.7 | 80   | 179.1 | 17.6 | 40   | 238.8 | 23.5 | 300  | 298.6 | 27.8 |
| Dist | Dep. | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat  |

for 7 1/2 Points.

TABLE II. Difference of Latitude and Departure for  $\frac{1}{2}$  Point.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat. | Dep |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|------|------|-----|
| 1    | 01.0 | 00.1 | 61   | 60.3  | 08.9 | 121  | 119.7 | 17.7 | 181  | 179.0 | 26.5 | 241  | 238.4 | 35.3 |      |      |     |
| 2    | 02.0 | 00.3 | 62   | 61.3  | 09.1 | 22   | 120.7 | 17.8 | 82   | 180.0 | 26.7 | 42   | 239.4 | 35.5 |      |      |     |
| 3    | 03.0 | 00.4 | 63   | 62.3  | 09.2 | 23   | 121.7 | 18.0 | 83   | 181.0 | 26.8 | 43   | 240.4 | 35.6 |      |      |     |
| 4    | 04.0 | 00.6 | 64   | 63.3  | 09.4 | 24   | 122.7 | 18.2 | 84   | 182.0 | 27.0 | 44   | 241.3 | 35.8 |      |      |     |
| 5    | 04.9 | 00.7 | 65   | 64.3  | 09.5 | 25   | 123.6 | 18.3 | 85   | 183.0 | 27.1 | 45   | 242.3 | 35.9 |      |      |     |
| 6    | 05.9 | 00.9 | 66   | 65.3  | 09.7 | 26   | 124.6 | 18.5 | 86   | 184.0 | 27.3 | 46   | 243.3 | 36.1 |      |      |     |
| 7    | 06.9 | 01.0 | 67   | 66.3  | 09.8 | 27   | 125.6 | 18.6 | 87   | 185.0 | 27.4 | 47   | 244.3 | 36.2 |      |      |     |
| 8    | 07.9 | 01.2 | 68   | 67.3  | 10.0 | 28   | 126.6 | 18.8 | 88   | 186.0 | 27.6 | 48   | 245.3 | 36.4 |      |      |     |
| 9    | 08.9 | 01.3 | 69   | 68.2  | 10.1 | 29   | 127.6 | 18.9 | 89   | 186.9 | 27.7 | 49   | 246.3 | 36.5 |      |      |     |
| 10   | 09.9 | 01.5 | 70   | 69.2  | 10.3 | 30   | 128.6 | 19.1 | 90   | 187.9 | 27.9 | 50   | 247.3 | 36.7 |      |      |     |
| 11   | 10.9 | 01.6 | 71   | 70.2  | 10.4 | 131  | 129.6 | 19.2 | 91   | 188.9 | 28.0 | 251  | 248.3 | 36.8 |      |      |     |
| 12   | 11.9 | 01.8 | 72   | 71.2  | 10.6 | 32   | 130.6 | 19.4 | 92   | 189.9 | 28.2 | 52   | 249.3 | 37.0 |      |      |     |
| 13   | 12.9 | 01.9 | 73   | 72.2  | 10.7 | 33   | 131.6 | 19.5 | 93   | 190.9 | 28.3 | 53   | 250.2 | 37.1 |      |      |     |
| 14   | 13.8 | 02.1 | 74   | 73.2  | 10.8 | 34   | 132.5 | 19.6 | 94   | 191.9 | 28.5 | 54   | 251.2 | 37.3 |      |      |     |
| 15   | 14.8 | 02.2 | 75   | 74.2  | 11.0 | 35   | 133.5 | 19.8 | 95   | 192.9 | 28.6 | 55   | 252.2 | 37.4 |      |      |     |
| 16   | 15.8 | 02.3 | 76   | 75.2  | 11.1 | 36   | 134.5 | 19.9 | 96   | 193.9 | 28.7 | 56   | 253.2 | 37.5 |      |      |     |
| 17   | 16.8 | 02.5 | 77   | 76.2  | 11.2 | 37   | 135.5 | 20.1 | 97   | 194.9 | 28.9 | 57   | 254.2 | 37.7 |      |      |     |
| 18   | 17.8 | 02.6 | 78   | 77.1  | 11.4 | 38   | 136.5 | 20.2 | 98   | 195.8 | 29.0 | 58   | 255.2 | 37.8 |      |      |     |
| 19   | 18.8 | 02.8 | 79   | 78.1  | 11.6 | 39   | 137.5 | 20.4 | 99   | 196.8 | 29.2 | 59   | 256.2 | 38.0 |      |      |     |
| 20   | 19.8 | 02.9 | 80   | 79.1  | 11.7 | 40   | 138.5 | 20.5 | 200  | 197.8 | 29.3 | 60   | 257.2 | 38.1 |      |      |     |
| 21   | 20.8 | 03.1 | 81   | 80.1  | 11.9 | 141  | 139.5 | 20.7 | 201  | 198.8 | 29.5 | 261  | 258.2 | 38.3 |      |      |     |
| 22   | 21.8 | 03.2 | 82   | 81.1  | 12.0 | 42   | 140.5 | 20.8 | 02   | 199.8 | 29.6 | 62   | 259.1 | 38.4 |      |      |     |
| 23   | 22.7 | 03.4 | 83   | 82.1  | 12.2 | 43   | 141.4 | 21.0 | 03   | 200.8 | 29.8 | 63   | 260.1 | 38.6 |      |      |     |
| 24   | 23.7 | 03.5 | 84   | 83.1  | 12.3 | 44   | 142.4 | 21.1 | 04   | 201.8 | 29.9 | 64   | 261.1 | 38.7 |      |      |     |
| 25   | 24.7 | 03.7 | 85   | 84.1  | 12.5 | 45   | 143.4 | 21.3 | 05   | 202.8 | 30.1 | 65   | 262.1 | 38.9 |      |      |     |
| 26   | 25.7 | 03.8 | 86   | 85.1  | 12.6 | 46   | 144.4 | 21.4 | 06   | 203.8 | 30.2 | 66   | 263.1 | 39.0 |      |      |     |
| 27   | 26.7 | 04.0 | 87   | 86.1  | 12.8 | 47   | 145.4 | 21.6 | 07   | 204.7 | 30.4 | 67   | 264.1 | 39.2 |      |      |     |
| 28   | 27.7 | 04.1 | 88   | 87.0  | 12.9 | 48   | 146.4 | 21.7 | 08   | 205.7 | 30.5 | 68   | 265.1 | 39.3 |      |      |     |
| 29   | 28.7 | 04.3 | 89   | 88.0  | 13.0 | 49   | 147.4 | 21.8 | 09   | 206.7 | 30.6 | 69   | 266.1 | 39.5 |      |      |     |
| 30   | 29.7 | 04.4 | 90   | 89.0  | 13.2 | 50   | 148.4 | 22.0 | 10   | 207.7 | 30.8 | 70   | 267.1 | 39.6 |      |      |     |
| 31   | 30.7 | 04.5 | 91   | 90.0  | 13.3 | 151  | 149.4 | 22.1 | 211  | 208.7 | 30.9 | 271  | 268.1 | 39.7 |      |      |     |
| 32   | 31.7 | 04.7 | 92   | 91.0  | 13.5 | 52   | 150.3 | 22.3 | 12   | 209.7 | 31.1 | 72   | 269.0 | 39.9 |      |      |     |
| 33   | 32.6 | 04.8 | 93   | 92.0  | 13.6 | 53   | 151.3 | 22.4 | 13   | 210.7 | 31.2 | 73   | 270.0 | 40.0 |      |      |     |
| 34   | 33.6 | 05.0 | 94   | 93.0  | 13.8 | 54   | 152.3 | 22.6 | 14   | 211.7 | 31.4 | 74   | 271.0 | 40.2 |      |      |     |
| 35   | 34.6 | 05.1 | 95   | 94.0  | 13.9 | 55   | 153.3 | 22.7 | 15   | 212.7 | 31.5 | 75   | 272.0 | 40.3 |      |      |     |
| 36   | 35.6 | 05.3 | 96   | 95.0  | 14.1 | 56   | 154.3 | 22.9 | 16   | 213.7 | 31.7 | 76   | 273.0 | 40.5 |      |      |     |
| 37   | 36.6 | 05.4 | 97   | 95.9  | 14.7 | 57   | 155.3 | 23.0 | 17   | 214.6 | 31.8 | 77   | 274.0 | 40.6 |      |      |     |
| 38   | 37.6 | 05.6 | 98   | 96.9  | 14.4 | 58   | 156.3 | 23.2 | 18   | 215.6 | 32.0 | 78   | 275.0 | 40.8 |      |      |     |
| 39   | 38.6 | 05.7 | 99   | 97.9  | 14.5 | 59   | 157.3 | 23.3 | 19   | 216.6 | 32.1 | 79   | 276.0 | 40.9 |      |      |     |
| 40   | 39.6 | 05.9 | 100  | 98.9  | 14.7 | 60   | 158.3 | 23.5 | 20   | 217.6 | 32.3 | 80   | 277.0 | 41.1 |      |      |     |
| 41   | 40.6 | 06.0 | 101  | 99.9  | 14.8 | 161  | 159.2 | 23.6 | 221  | 218.6 | 32.4 | 281  | 277.9 | 41.2 |      |      |     |
| 42   | 41.5 | 06.2 | 02   | 100.9 | 15.0 | 62   | 160.2 | 23.8 | 22   | 219.6 | 32.6 | 82   | 278.9 | 41.4 |      |      |     |
| 43   | 42.5 | 06.3 | 03   | 101.9 | 15.1 | 63   | 161.2 | 23.9 | 23   | 220.6 | 32.7 | 83   | 279.9 | 41.5 |      |      |     |
| 44   | 43.5 | 06.5 | 04   | 102.9 | 15.3 | 64   | 162.2 | 24.0 | 24   | 221.6 | 32.8 | 84   | 280.9 | 41.6 |      |      |     |
| 45   | 44.5 | 06.6 | 05   | 103.9 | 15.4 | 65   | 163.2 | 24.2 | 25   | 222.6 | 33.0 | 85   | 281.9 | 41.8 |      |      |     |
| 46   | 45.5 | 06.7 | 06   | 104.8 | 15.5 | 66   | 164.2 | 24.3 | 26   | 223.5 | 33.1 | 86   | 282.9 | 41.9 |      |      |     |
| 47   | 46.5 | 06.9 | 07   | 105.8 | 15.7 | 67   | 165.2 | 24.5 | 27   | 224.5 | 33.3 | 87   | 283.9 | 42.1 |      |      |     |
| 48   | 47.5 | 07.0 | 08   | 106.8 | 15.8 | 68   | 166.2 | 24.6 | 28   | 225.5 | 33.4 | 88   | 284.9 | 42.2 |      |      |     |
| 49   | 48.5 | 07.2 | 09   | 107.8 | 16.0 | 69   | 167.2 | 24.8 | 29   | 226.5 | 33.6 | 89   | 285.9 | 42.4 |      |      |     |
| 50   | 49.5 | 07.3 | 10   | 108.8 | 16.1 | 70   | 168.1 | 24.9 | 30   | 227.5 | 33.7 | 90   | 286.9 | 42.5 |      |      |     |
| 51   | 50.4 | 07.5 | 111  | 109.8 | 16.3 | 171  | 169.1 | 25.1 | 231  | 228.5 | 33.9 | 291  | 287.8 | 42.7 |      |      |     |
| 52   | 51.4 | 07.6 | 12   | 110.8 | 16.4 | 72   | 170.1 | 25.2 | 32   | 229.5 | 34.0 | 92   | 288.8 | 42.8 |      |      |     |
| 53   | 52.4 | 07.8 | 13   | 111.8 | 16.6 | 73   | 171.1 | 25.4 | 33   | 230.5 | 34.2 | 93   | 289.8 | 43.0 |      |      |     |
| 54   | 53.4 | 07.9 | 14   | 112.8 | 16.7 | 74   | 172.1 | 25.5 | 34   | 231.5 | 34.3 | 94   | 290.8 | 43.1 |      |      |     |
| 55   | 54.4 | 08.1 | 15   | 113.7 | 16.9 | 75   | 173.1 | 25.7 | 35   | 232.4 | 34.5 | 95   | 291.8 | 43.3 |      |      |     |
| 56   | 55.4 | 08.2 | 16   | 114.7 | 17.0 | 76   | 174.1 | 25.8 | 36   | 233.4 | 34.6 | 96   | 292.8 | 43.4 |      |      |     |
| 57   | 56.4 | 08.4 | 17   | 115.7 | 17.2 | 77   | 175.1 | 26.0 | 37   | 234.4 | 34.8 | 97   | 293.8 | 43.6 |      |      |     |
| 58   | 57.4 | 08.5 | 18   | 116.7 | 17.3 | 78   | 176.1 | 26.1 | 38   | 235.4 | 34.9 | 98   | 294.8 | 43.7 |      |      |     |
| 59   | 58.4 | 08.6 | 19   | 117.7 | 17.5 | 79   | 177.1 | 26.3 | 39   | 236.4 | 35.0 | 99   | 295.8 | 43.8 |      |      |     |
| 60   | 59.3 | 08.8 | 120  | 118.7 | 17.6 | 180  | 178.0 | 26.4 | 240  | 237.4 | 35.2 | 300  | 296.8 | 44.0 |      |      |     |
| Dist | Dep. | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat  | Dist | Dep. | Lat |

B b

for  $7\frac{1}{4}$  Points.

TABLE II. Difference of Latitude and Departure for 1 Point.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.2 | 61   | 59.8  | 11.9 | 121  | 118.7 | 23.6 | 181  | 177.5 | 35.3 | 241  | 236.2 | 47.6 |
| 2    | 02.0 | 00.4 | 62   | 60.8  | 12.1 | 22   | 119.6 | 23.8 | 82   | 178.5 | 35.5 | 42   | 237.2 | 47.7 |
| 3    | 03.0 | 00.6 | 63   | 61.8  | 12.3 | 23   | 120.6 | 24.0 | 83   | 179.5 | 35.7 | 43   | 238.2 | 47.8 |
| 4    | 04.0 | 00.8 | 64   | 62.8  | 12.5 | 24   | 121.6 | 24.2 | 84   | 180.4 | 35.9 | 44   | 239.2 | 47.9 |
| 5    | 05.0 | 01.0 | 65   | 63.7  | 12.7 | 25   | 122.6 | 24.4 | 85   | 181.4 | 36.1 | 45   | 240.2 | 48.0 |
| 6    | 05.9 | 01.2 | 66   | 64.7  | 12.9 | 26   | 123.6 | 24.6 | 86   | 182.4 | 36.3 | 46   | 241.2 | 48.1 |
| 7    | 06.9 | 01.4 | 67   | 65.7  | 13.1 | 27   | 124.5 | 24.8 | 87   | 183.4 | 36.5 | 47   | 242.2 | 48.2 |
| 8    | 07.8 | 01.6 | 68   | 66.7  | 13.3 | 28   | 125.5 | 25.0 | 88   | 184.4 | 36.7 | 48   | 243.2 | 48.3 |
| 9    | 08.8 | 01.8 | 69   | 67.7  | 13.5 | 29   | 126.5 | 25.2 | 89   | 185.3 | 36.9 | 49   | 244.2 | 48.4 |
| 10   | 09.8 | 02.0 | 70   | 68.6  | 13.7 | 30   | 127.5 | 25.4 | 90   | 186.3 | 37.1 | 50   | 245.2 | 48.5 |
| 11   | 10.8 | 02.1 | 71   | 69.6  | 13.9 | 31   | 128.5 | 25.6 | 191  | 187.3 | 37.3 | 251  | 246.1 | 49.0 |
| 12   | 11.8 | 02.3 | 72   | 70.6  | 14.0 | 32   | 129.5 | 25.8 | 92   | 188.3 | 37.5 | 52   | 247.1 | 49.1 |
| 13   | 12.7 | 02.5 | 73   | 71.6  | 14.2 | 33   | 130.4 | 26.0 | 93   | 189.3 | 37.7 | 53   | 248.1 | 49.2 |
| 14   | 13.7 | 02.7 | 74   | 72.6  | 14.4 | 34   | 131.4 | 26.1 | 94   | 190.2 | 37.9 | 54   | 249.1 | 49.3 |
| 15   | 14.7 | 02.9 | 75   | 73.6  | 14.6 | 35   | 132.4 | 26.3 | 95   | 191.2 | 38.0 | 55   | 250.1 | 49.4 |
| 16   | 15.7 | 03.1 | 76   | 74.5  | 14.8 | 36   | 133.4 | 26.5 | 96   | 192.2 | 38.2 | 56   | 251.1 | 49.5 |
| 17   | 16.7 | 03.3 | 77   | 75.5  | 15.0 | 37   | 134.4 | 26.7 | 97   | 193.2 | 38.4 | 57   | 252.1 | 49.6 |
| 18   | 17.7 | 03.5 | 78   | 76.5  | 15.2 | 38   | 135.3 | 26.9 | 98   | 194.2 | 38.6 | 58   | 253.0 | 49.7 |
| 19   | 18.6 | 03.7 | 79   | 77.5  | 15.4 | 39   | 136.3 | 27.1 | 99   | 195.2 | 38.8 | 59   | 254.0 | 49.8 |
| 20   | 19.6 | 03.9 | 80   | 78.5  | 15.6 | 40   | 137.3 | 27.3 | 200  | 196.1 | 39.0 | 60   | 255.0 | 49.9 |
| 21   | 20.6 | 04.1 | 81   | 79.4  | 15.8 | 41   | 138.3 | 27.5 | 201  | 197.1 | 39.2 | 261  | 256.0 | 50.0 |
| 22   | 21.6 | 04.3 | 82   | 80.4  | 16.0 | 42   | 139.3 | 27.7 | 02   | 198.1 | 39.4 | 62   | 256.9 | 51.1 |
| 23   | 22.6 | 04.5 | 83   | 81.4  | 16.2 | 43   | 140.2 | 27.9 | 03   | 199.1 | 39.6 | 63   | 257.9 | 51.2 |
| 24   | 23.5 | 04.7 | 84   | 82.4  | 16.4 | 44   | 141.2 | 28.1 | 04   | 200.1 | 39.8 | 64   | 258.9 | 51.3 |
| 25   | 24.5 | 04.9 | 85   | 83.4  | 16.6 | 45   | 142.2 | 28.3 | 05   | 201.0 | 40.0 | 65   | 259.9 | 51.4 |
| 26   | 25.5 | 05.1 | 86   | 84.3  | 16.8 | 46   | 143.2 | 28.5 | 06   | 202.0 | 40.2 | 66   | 260.9 | 51.5 |
| 27   | 26.5 | 05.3 | 87   | 85.3  | 17.0 | 47   | 144.2 | 28.7 | 07   | 203.0 | 40.4 | 67   | 261.8 | 52.2 |
| 28   | 27.5 | 05.5 | 88   | 86.3  | 17.2 | 48   | 145.1 | 28.9 | 08   | 204.0 | 40.6 | 68   | 262.8 | 52.3 |
| 29   | 28.4 | 05.7 | 89   | 87.3  | 17.4 | 49   | 146.1 | 29.1 | 09   | 205.0 | 40.8 | 69   | 263.8 | 52.4 |
| 30   | 29.4 | 05.9 | 90   | 88.3  | 17.6 | 50   | 147.1 | 29.3 | 10   | 205.9 | 41.0 | 70   | 264.8 | 52.5 |
| 31   | 30.4 | 06.0 | 91   | 89.2  | 17.8 | 151  | 148.1 | 29.5 | 211  | 206.9 | 41.2 | 271  | 265.8 | 52.6 |
| 32   | 31.4 | 06.2 | 92   | 90.2  | 18.0 | 52   | 149.1 | 29.7 | 12   | 207.9 | 41.4 | 72   | 266.7 | 53.3 |
| 33   | 32.4 | 06.4 | 93   | 91.2  | 18.1 | 53   | 150.0 | 29.9 | 13   | 208.9 | 41.6 | 73   | 267.7 | 53.4 |
| 34   | 33.3 | 06.6 | 94   | 92.2  | 18.3 | 54   | 151.0 | 30.0 | 14   | 209.9 | 41.8 | 74   | 268.7 | 53.5 |
| 35   | 34.3 | 06.8 | 95   | 93.2  | 18.5 | 55   | 152.0 | 30.2 | 15   | 210.8 | 42.0 | 75   | 269.7 | 53.6 |
| 36   | 35.3 | 07.0 | 96   | 94.1  | 18.7 | 56   | 153.0 | 30.4 | 16   | 211.8 | 42.1 | 76   | 270.7 | 53.7 |
| 37   | 36.3 | 07.2 | 97   | 95.1  | 18.9 | 57   | 154.0 | 30.6 | 17   | 212.8 | 42.3 | 77   | 271.6 | 54.4 |
| 38   | 37.3 | 07.4 | 98   | 96.1  | 19.1 | 58   | 154.9 | 30.8 | 18   | 213.8 | 42.5 | 78   | 272.6 | 54.5 |
| 39   | 38.2 | 07.6 | 99   | 97.1  | 19.3 | 59   | 155.9 | 31.0 | 19   | 214.8 | 42.7 | 79   | 273.6 | 54.6 |
| 40   | 39.2 | 07.8 | 100  | 98.1  | 19.5 | 60   | 156.9 | 31.2 | 20   | 215.7 | 42.9 | 80   | 274.6 | 54.7 |
| 41   | 40.2 | 08.0 | 101  | 99.1  | 19.7 | 161  | 157.9 | 31.4 | 221  | 216.7 | 43.1 | 281  | 275.6 | 54.8 |
| 42   | 41.2 | 08.2 | 02   | 100.0 | 19.9 | 62   | 158.9 | 31.6 | 22   | 217.7 | 43.3 | 82   | 276.5 | 55.5 |
| 43   | 42.2 | 08.4 | 03   | 101.0 | 20.1 | 63   | 159.8 | 31.8 | 23   | 218.7 | 43.5 | 83   | 277.5 | 55.6 |
| 44   | 43.2 | 08.6 | 04   | 102.0 | 20.3 | 64   | 160.8 | 32.0 | 24   | 219.7 | 43.7 | 84   | 278.5 | 55.7 |
| 45   | 44.1 | 08.8 | 05   | 103.0 | 20.5 | 65   | 161.8 | 32.2 | 25   | 220.6 | 43.9 | 85   | 279.5 | 55.8 |
| 46   | 45.1 | 09.0 | 06   | 104.0 | 20.7 | 66   | 162.8 | 32.4 | 26   | 221.6 | 44.1 | 86   | 280.5 | 55.9 |
| 47   | 46.1 | 09.2 | 07   | 104.9 | 20.9 | 67   | 163.8 | 32.6 | 27   | 222.6 | 44.3 | 87   | 281.5 | 56.6 |
| 48   | 47.1 | 09.4 | 08   | 105.9 | 21.1 | 68   | 164.7 | 32.8 | 28   | 223.6 | 44.5 | 88   | 282.4 | 56.7 |
| 49   | 48.1 | 09.6 | 09   | 106.9 | 21.3 | 69   | 165.7 | 33.0 | 29   | 224.6 | 44.7 | 89   | 283.4 | 56.8 |
| 50   | 49.0 | 09.8 | 10   | 107.9 | 21.5 | 70   | 166.7 | 33.2 | 30   | 225.6 | 44.9 | 90   | 284.4 | 56.9 |
| 51   | 50.0 | 10.0 | 111  | 108.9 | 21.7 | 171  | 167.7 | 33.4 | 231  | 226.5 | 45.1 | 291  | 285.4 | 57.0 |
| 52   | 51.0 | 10.1 | 12   | 109.8 | 21.9 | 72   | 168.7 | 33.6 | 32   | 227.5 | 45.3 | 92   | 286.4 | 57.1 |
| 53   | 52.0 | 10.3 | 13   | 110.8 | 22.0 | 73   | 169.7 | 33.8 | 33   | 228.5 | 45.5 | 93   | 287.3 | 57.2 |
| 54   | 53.0 | 10.5 | 14   | 111.8 | 22.2 | 74   | 170.6 | 34.0 | 34   | 229.5 | 45.7 | 94   | 288.3 | 57.3 |
| 55   | 53.9 | 10.7 | 15   | 112.8 | 22.4 | 75   | 171.6 | 34.1 | 35   | 230.5 | 45.9 | 95   | 289.3 | 57.4 |
| 56   | 54.9 | 10.9 | 16   | 113.8 | 22.6 | 76   | 172.6 | 34.3 | 36   | 231.4 | 46.0 | 96   | 290.3 | 57.5 |
| 57   | 55.9 | 11.1 | 17   | 114.7 | 22.8 | 77   | 173.6 | 34.5 | 38   | 232.4 | 46.2 | 97   | 291.3 | 58.2 |
| 58   | 56.9 | 11.3 | 18   | 115.7 | 23.0 | 78   | 174.6 | 34.7 | 38   | 233.4 | 46.4 | 98   | 292.2 | 58.3 |
| 59   | 57.9 | 11.5 | 19   | 116.7 | 23.2 | 79   | 175.5 | 34.9 | 39   | 234.4 | 46.6 | 99   | 293.2 | 58.4 |
| 60   | 58.8 | 11.7 | 120  | 117.7 | 23.4 | 80   | 176.5 | 35.1 | 40   | 235.4 | 46.8 | 300  | 294.2 | 58.5 |
| Dist | Dep. | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat  |

for 7 Points.



TABLE II. Difference of Latitude and Departure for 1  $\frac{1}{2}$  Point.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 30.2 | 61   | 59.2  | 14.8 | 121  | 117.4 | 29.4 | 181  | 175.6 | 44.0 | 241  | 233.8 | 58.6 |
| 2    | 01.9 | 30.5 | 62   | 60.1  | 15.1 | 22   | 118.3 | 29.6 | 82   | 176.5 | 44.2 | 42   | 234.7 | 58.8 |
| 3    | 02.9 | 30.7 | 63   | 61.1  | 15.3 | 23   | 119.3 | 29.9 | 83   | 177.5 | 44.5 | 43   | 235.7 | 59.0 |
| 4    | 03.9 | 31.0 | 64   | 62.1  | 15.6 | 24   | 120.3 | 30.1 | 84   | 178.5 | 44.7 | 44   | 236.7 | 59.3 |
| 5    | 04.9 | 31.2 | 65   | 63.1  | 15.8 | 25   | 121.3 | 30.4 | 85   | 179.5 | 45.0 | 45   | 237.7 | 59.5 |
| 6    | 05.8 | 31.5 | 66   | 64.0  | 16.0 | 26   | 122.2 | 30.6 | 86   | 180.4 | 45.2 | 46   | 238.6 | 59.8 |
| 7    | 06.8 | 31.7 | 67   | 65.0  | 16.3 | 27   | 123.2 | 30.9 | 87   | 181.4 | 45.4 | 47   | 239.6 | 60.0 |
| 8    | 07.8 | 31.9 | 68   | 66.0  | 16.5 | 28   | 124.2 | 31.1 | 88   | 182.4 | 45.7 | 48   | 240.6 | 60.3 |
| 9    | 08.7 | 32.2 | 69   | 66.9  | 16.8 | 29   | 125.1 | 31.3 | 89   | 183.3 | 45.9 | 49   | 241.5 | 60.5 |
| 10   | 09.7 | 32.4 | 70   | 67.9  | 17.0 | 30   | 126.1 | 31.6 | 90   | 184.3 | 46.2 | 50   | 242.5 | 60.7 |
| 11   | 10.7 | 32.7 | 71   | 68.9  | 17.3 | 31   | 127.1 | 31.8 | 191  | 185.3 | 46.4 | 251  | 243.5 | 61.0 |
| 12   | 11.6 | 32.9 | 72   | 69.8  | 17.5 | 32   | 128.0 | 32.1 | 92   | 186.2 | 46.7 | 52   | 244.4 | 61.2 |
| 13   | 12.6 | 33.4 | 73   | 70.8  | 17.7 | 33   | 129.0 | 32.3 | 93   | 187.2 | 46.9 | 53   | 245.4 | 61.5 |
| 14   | 13.6 | 33.2 | 74   | 71.8  | 18.0 | 34   | 130.0 | 32.6 | 94   | 188.2 | 47.1 | 54   | 246.4 | 61.7 |
| 15   | 14.6 | 33.6 | 75   | 72.8  | 18.2 | 35   | 131.0 | 32.8 | 95   | 189.2 | 47.4 | 55   | 247.4 | 62.0 |
| 16   | 15.5 | 33.9 | 76   | 73.7  | 18.5 | 36   | 131.9 | 33.0 | 96   | 190.1 | 47.6 | 56   | 248.3 | 62.2 |
| 17   | 16.5 | 34.1 | 77   | 74.7  | 18.7 | 37   | 132.9 | 33.3 | 97   | 191.1 | 47.9 | 57   | 249.3 | 62.5 |
| 18   | 17.5 | 34.4 | 78   | 75.7  | 19.0 | 38   | 133.9 | 33.5 | 98   | 192.1 | 48.1 | 58   | 250.3 | 62.7 |
| 19   | 18.4 | 34.6 | 79   | 76.6  | 19.2 | 39   | 134.8 | 33.8 | 99   | 193.0 | 48.4 | 59   | 251.2 | 62.9 |
| 20   | 19.4 | 34.9 | 80   | 77.6  | 19.4 | 40   | 135.8 | 34.0 | 200  | 194.0 | 48.6 | 60   | 252.2 | 63.2 |
| 21   | 20.4 | 35.1 | 81   | 78.6  | 19.7 | 41   | 136.8 | 34.3 | 201  | 195.0 | 48.8 | 261  | 253.2 | 63.4 |
| 22   | 21.3 | 35.3 | 82   | 79.5  | 19.9 | 42   | 137.7 | 34.5 | 02   | 195.9 | 49.1 | 62   | 254.1 | 63.7 |
| 23   | 22.3 | 35.6 | 83   | 80.5  | 20.2 | 43   | 138.7 | 34.7 | 03   | 196.9 | 49.3 | 63   | 255.1 | 63.9 |
| 24   | 23.3 | 35.8 | 84   | 81.5  | 20.4 | 44   | 139.7 | 35.0 | 04   | 197.9 | 49.6 | 64   | 256.1 | 64.2 |
| 25   | 24.3 | 36.1 | 85   | 82.5  | 20.7 | 45   | 140.7 | 35.2 | 05   | 198.9 | 49.8 | 65   | 257.1 | 64.4 |
| 26   | 25.2 | 36.3 | 86   | 83.4  | 20.9 | 46   | 141.6 | 35.5 | 06   | 199.8 | 50.1 | 66   | 258.0 | 64.6 |
| 27   | 26.2 | 36.6 | 87   | 84.4  | 21.1 | 47   | 142.6 | 35.7 | 07   | 200.8 | 50.3 | 67   | 259.0 | 64.9 |
| 28   | 27.2 | 36.8 | 88   | 85.4  | 21.4 | 48   | 143.6 | 36.0 | 08   | 201.8 | 50.5 | 68   | 260.0 | 65.1 |
| 29   | 28.1 | 37.0 | 89   | 86.3  | 21.6 | 49   | 144.5 | 36.2 | 09   | 202.7 | 50.8 | 69   | 260.9 | 65.4 |
| 30   | 29.1 | 37.3 | 90   | 87.3  | 21.9 | 50   | 145.5 | 36.5 | 10   | 203.7 | 51.0 | 70   | 261.9 | 65.6 |
| 31   | 30.1 | 37.5 | 91   | 88.3  | 22.1 | 51   | 146.5 | 36.7 | 211  | 204.7 | 51.3 | 271  | 262.9 | 65.9 |
| 32   | 31.0 | 37.8 | 92   | 89.2  | 22.4 | 52   | 147.4 | 36.9 | 12   | 205.6 | 51.5 | 72   | 263.8 | 66.1 |
| 33   | 32.0 | 38.0 | 93   | 90.2  | 22.6 | 53   | 148.4 | 37.2 | 13   | 206.6 | 51.8 | 73   | 264.8 | 66.3 |
| 34   | 33.0 | 38.3 | 94   | 91.2  | 22.8 | 54   | 149.4 | 37.4 | 14   | 207.6 | 52.0 | 74   | 265.8 | 66.6 |
| 35   | 34.0 | 38.5 | 95   | 92.2  | 23.1 | 55   | 150.4 | 37.7 | 15   | 208.6 | 52.2 | 75   | 266.8 | 66.8 |
| 36   | 34.9 | 38.7 | 96   | 93.1  | 23.3 | 56   | 151.3 | 37.9 | 16   | 209.5 | 52.5 | 76   | 267.7 | 67.1 |
| 37   | 35.9 | 39.0 | 97   | 94.1  | 23.6 | 57   | 152.3 | 38.2 | 17   | 210.5 | 52.7 | 77   | 268.7 | 67.3 |
| 38   | 36.9 | 39.2 | 98   | 95.1  | 23.8 | 58   | 153.3 | 38.4 | 18   | 211.5 | 53.0 | 78   | 269.7 | 67.6 |
| 39   | 37.8 | 39.5 | 99   | 96.0  | 24.1 | 59   | 154.2 | 38.6 | 19   | 212.4 | 53.2 | 79   | 270.6 | 67.8 |
| 40   | 38.8 | 39.7 | 100  | 97.0  | 24.3 | 60   | 155.2 | 38.9 | 20   | 213.4 | 53.5 | 80   | 271.6 | 68.0 |
| 41   | 39.8 | 40.0 | 101  | 98.0  | 24.5 | 61   | 156.2 | 39.1 | 221  | 214.4 | 53.7 | 281  | 272.6 | 68.3 |
| 42   | 40.7 | 40.2 | 02   | 98.9  | 24.8 | 62   | 157.1 | 39.4 | 22   | 215.3 | 53.9 | 82   | 273.5 | 68.5 |
| 43   | 41.7 | 40.4 | 03   | 99.9  | 25.0 | 63   | 158.1 | 39.6 | 23   | 216.3 | 54.2 | 83   | 274.5 | 68.8 |
| 44   | 42.7 | 40.7 | 04   | 100.9 | 25.3 | 64   | 159.1 | 39.9 | 24   | 217.3 | 54.4 | 84   | 275.5 | 69.0 |
| 45   | 43.7 | 41.0 | 05   | 101.9 | 25.5 | 65   | 160.1 | 40.1 | 25   | 218.3 | 54.7 | 85   | 276.5 | 69.3 |
| 46   | 44.6 | 41.2 | 06   | 102.8 | 25.8 | 66   | 161.0 | 40.3 | 26   | 219.2 | 54.9 | 86   | 277.4 | 69.5 |
| 47   | 45.6 | 41.4 | 07   | 103.8 | 26.0 | 67   | 162.0 | 40.6 | 27   | 220.2 | 55.2 | 87   | 278.4 | 69.7 |
| 48   | 46.6 | 41.7 | 08   | 104.8 | 26.2 | 68   | 163.0 | 40.8 | 28   | 221.2 | 55.4 | 88   | 279.4 | 70.0 |
| 49   | 47.5 | 41.9 | 09   | 105.7 | 26.5 | 69   | 163.9 | 41.1 | 29   | 222.1 | 55.6 | 89   | 280.3 | 70.2 |
| 50   | 48.5 | 42.2 | 110  | 106.7 | 26.7 | 70   | 164.9 | 41.3 | 30   | 223.1 | 55.9 | 90   | 281.3 | 70.5 |
| 51   | 49.5 | 42.4 | 111  | 107.7 | 27.0 | 71   | 165.9 | 41.6 | 231  | 224.1 | 56.1 | 291  | 282.3 | 70.7 |
| 52   | 50.4 | 42.6 | 12   | 108.6 | 27.2 | 72   | 166.8 | 41.8 | 32   | 225.0 | 56.4 | 92   | 283.2 | 71.0 |
| 53   | 51.4 | 42.9 | 13   | 109.6 | 27.5 | 73   | 167.8 | 42.0 | 33   | 226.0 | 56.6 | 93   | 284.2 | 71.2 |
| 54   | 52.4 | 43.1 | 14   | 110.6 | 27.7 | 74   | 168.8 | 42.3 | 34   | 227.0 | 56.9 | 94   | 285.2 | 71.4 |
| 55   | 53.4 | 43.4 | 15   | 111.6 | 27.9 | 75   | 169.8 | 42.5 | 35   | 228.0 | 57.1 | 95   | 286.2 | 71.7 |
| 56   | 54.3 | 43.6 | 16   | 112.5 | 28.2 | 76   | 170.7 | 42.8 | 36   | 228.9 | 57.3 | 96   | 287.1 | 71.9 |
| 57   | 55.3 | 43.9 | 17   | 113.5 | 28.4 | 77   | 171.7 | 43.0 | 37   | 229.9 | 57.6 | 97   | 288.1 | 72.2 |
| 58   | 56.3 | 44.1 | 18   | 114.5 | 28.7 | 78   | 172.7 | 43.3 | 38   | 230.9 | 57.8 | 98   | 289.1 | 72.4 |
| 59   | 57.2 | 44.3 | 19   | 115.4 | 28.9 | 79   | 173.6 | 43.5 | 39   | 231.8 | 58.1 | 99   | 290.0 | 72.7 |
| 60   | 58.2 | 44.6 | 120  | 116.4 | 29.2 | 80   | 174.6 | 43.7 | 40   | 232.8 | 58.3 | 300  | 291.0 | 72.9 |

for 6  $\frac{1}{2}$  Points.

TABLE II. Difference of Latitude and Departure for 1 Point.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.3 | 61   | 58.4  | 17.7 | 121  | 115.8 | 35.1 | 181  | 173.2 | 52.5 | 241  | 230.6 | 69.5 |
| 2    | 01.9 | 00.6 | 62   | 59.3  | 18.0 | 22   | 116.8 | 35.4 | 82   | 174.2 | 52.8 | 42   | 231.6 | 70.2 |
| 3    | 02.9 | 00.9 | 63   | 60.3  | 18.3 | 23   | 117.7 | 35.7 | 83   | 175.1 | 53.1 | 43   | 232.5 | 70.5 |
| 4    | 03.8 | 01.2 | 64   | 61.2  | 18.6 | 24   | 118.7 | 36.0 | 84   | 176.1 | 53.4 | 44   | 233.5 | 70.8 |
| 5    | 04.8 | 01.5 | 65   | 62.2  | 18.9 | 25   | 119.6 | 36.3 | 85   | 177.0 | 53.7 | 45   | 234.5 | 71.1 |
| 6    | 05.7 | 01.7 | 66   | 63.2  | 19.1 | 26   | 120.6 | 36.5 | 86   | 178.0 | 53.9 | 46   | 235.4 | 71.4 |
| 7    | 05.7 | 02.0 | 67   | 64.1  | 19.4 | 27   | 121.5 | 36.8 | 87   | 179.0 | 54.2 | 47   | 236.4 | 71.7 |
| 8    | 07.7 | 02.3 | 68   | 65.1  | 19.7 | 28   | 122.5 | 37.1 | 88   | 179.9 | 54.5 | 48   | 237.3 | 71.9 |
| 9    | 08.6 | 02.6 | 69   | 66.0  | 20.0 | 29   | 123.5 | 37.4 | 89   | 180.9 | 54.8 | 49   | 238.3 | 72.2 |
| 10   | 09.6 | 02.9 | 70   | 67.0  | 20.3 | 30   | 124.4 | 37.7 | 90   | 181.8 | 55.1 | 50   | 239.2 | 72.5 |
| 11   | 10.5 | 03.2 | 71   | 67.9  | 20.6 | 131  | 125.4 | 38.0 | 191  | 182.8 | 55.4 | 251  | 240.2 | 72.8 |
| 12   | 11.5 | 03.5 | 72   | 68.9  | 20.9 | 32   | 126.3 | 38.3 | 92   | 183.7 | 55.7 | 52   | 241.2 | 73.1 |
| 13   | 12.4 | 03.8 | 73   | 69.9  | 21.2 | 33   | 127.3 | 38.6 | 93   | 184.7 | 56.0 | 53   | 242.1 | 73.4 |
| 14   | 13.4 | 04.1 | 74   | 70.8  | 21.5 | 34   | 128.2 | 38.9 | 94   | 185.7 | 56.3 | 54   | 243.1 | 73.7 |
| 15   | 14.4 | 04.4 | 75   | 71.8  | 21.8 | 35   | 129.2 | 39.2 | 95   | 186.6 | 56.6 | 55   | 244.0 | 74.0 |
| 16   | 15.3 | 04.6 | 76   | 72.7  | 22.0 | 36   | 130.2 | 39.4 | 96   | 187.6 | 56.8 | 56   | 245.0 | 74.3 |
| 17   | 16.3 | 04.9 | 77   | 73.7  | 22.3 | 37   | 131.1 | 39.7 | 97   | 188.5 | 57.1 | 57   | 245.9 | 74.6 |
| 18   | 17.2 | 05.2 | 78   | 74.6  | 22.6 | 38   | 132.1 | 40.0 | 98   | 189.5 | 57.4 | 58   | 246.9 | 74.9 |
| 19   | 18.2 | 05.5 | 79   | 75.6  | 22.9 | 39   | 133.0 | 40.3 | 99   | 190.4 | 57.7 | 59   | 247.9 | 75.2 |
| 20   | 19.1 | 05.8 | 80   | 76.6  | 23.2 | 40   | 134.0 | 40.6 | 200  | 191.4 | 58.0 | 60   | 248.8 | 75.5 |
| 21   | 20.1 | 06.1 | 81   | 77.5  | 23.5 | 141  | 134.9 | 40.9 | 201  | 192.4 | 58.3 | 261  | 249.8 | 75.8 |
| 22   | 21.1 | 06.4 | 82   | 78.5  | 23.8 | 42   | 135.9 | 41.2 | 02   | 193.3 | 58.6 | 62   | 250.7 | 76.1 |
| 23   | 22.0 | 06.7 | 83   | 79.4  | 24.1 | 43   | 136.9 | 41.5 | 03   | 194.3 | 58.9 | 63   | 251.7 | 76.4 |
| 24   | 23.0 | 07.0 | 84   | 80.4  | 24.4 | 44   | 137.8 | 41.8 | 04   | 195.2 | 59.2 | 64   | 252.6 | 76.7 |
| 25   | 23.9 | 07.3 | 85   | 81.3  | 24.7 | 45   | 138.8 | 42.1 | 05   | 196.2 | 59.5 | 65   | 253.6 | 77.0 |
| 26   | 24.9 | 07.5 | 86   | 82.3  | 24.9 | 46   | 139.7 | 42.3 | 06   | 197.1 | 59.7 | 66   | 254.6 | 77.3 |
| 27   | 25.8 | 07.8 | 87   | 83.3  | 25.2 | 47   | 140.7 | 42.6 | 07   | 198.1 | 60.0 | 67   | 255.5 | 77.6 |
| 28   | 26.8 | 08.1 | 88   | 84.2  | 25.5 | 48   | 141.6 | 42.9 | 08   | 199.1 | 60.3 | 68   | 256.5 | 77.9 |
| 29   | 27.8 | 08.4 | 89   | 85.2  | 25.8 | 49   | 142.6 | 43.2 | 09   | 200.0 | 60.6 | 69   | 257.4 | 78.2 |
| 30   | 28.7 | 08.7 | 90   | 86.1  | 26.1 | 50   | 143.5 | 43.5 | 10   | 201.0 | 60.9 | 70   | 258.4 | 78.5 |
| 31   | 29.7 | 09.0 | 91   | 87.1  | 26.4 | 151  | 144.5 | 43.8 | 211  | 201.9 | 61.2 | 271  | 259.3 | 78.8 |
| 32   | 30.6 | 09.3 | 92   | 88.0  | 26.7 | 52   | 145.5 | 44.1 | 12   | 202.9 | 61.5 | 72   | 260.3 | 79.1 |
| 33   | 31.6 | 09.6 | 93   | 89.0  | 27.0 | 53   | 146.4 | 44.4 | 13   | 203.8 | 61.8 | 73   | 261.3 | 79.4 |
| 34   | 32.5 | 09.9 | 94   | 90.0  | 27.3 | 54   | 147.4 | 44.7 | 14   | 204.8 | 62.1 | 74   | 262.2 | 79.7 |
| 35   | 33.5 | 10.2 | 95   | 90.9  | 27.6 | 55   | 148.3 | 45.0 | 15   | 205.8 | 62.4 | 75   | 263.2 | 80.0 |
| 36   | 34.5 | 10.4 | 96   | 91.9  | 27.8 | 56   | 149.3 | 45.2 | 16   | 206.7 | 62.6 | 76   | 264.1 | 80.3 |
| 37   | 35.4 | 10.7 | 97   | 92.8  | 28.1 | 57   | 150.2 | 45.5 | 17   | 207.7 | 62.9 | 77   | 265.1 | 80.6 |
| 38   | 36.4 | 11.0 | 98   | 93.8  | 28.4 | 58   | 151.2 | 45.8 | 18   | 208.6 | 63.2 | 78   | 266.0 | 80.9 |
| 39   | 37.3 | 11.3 | 99   | 94.7  | 28.7 | 59   | 152.2 | 46.1 | 19   | 209.6 | 63.5 | 79   | 267.0 | 81.2 |
| 40   | 38.3 | 11.6 | 100  | 95.7  | 29.0 | 60   | 153.1 | 46.4 | 20   | 210.5 | 63.8 | 80   | 268.0 | 81.5 |
| 41   | 39.2 | 11.9 | 101  | 96.7  | 29.3 | 161  | 154.1 | 46.7 | 221  | 211.5 | 64.1 | 281  | 268.9 | 81.8 |
| 42   | 40.2 | 12.2 | 02   | 97.6  | 29.6 | 62   | 155.0 | 47.0 | 22   | 212.5 | 64.4 | 82   | 269.9 | 82.1 |
| 43   | 41.2 | 12.5 | 03   | 98.6  | 29.9 | 63   | 156.0 | 47.3 | 23   | 213.4 | 64.7 | 83   | 270.8 | 82.4 |
| 44   | 42.1 | 12.8 | 04   | 99.5  | 30.2 | 64   | 156.9 | 47.6 | 24   | 214.4 | 65.0 | 84   | 271.8 | 82.7 |
| 45   | 43.1 | 13.1 | 05   | 100.5 | 30.5 | 65   | 157.9 | 47.9 | 25   | 215.3 | 65.3 | 85   | 272.7 | 83.0 |
| 46   | 44.0 | 13.3 | 06   | 101.4 | 30.7 | 66   | 158.9 | 48.1 | 26   | 216.3 | 65.5 | 86   | 273.7 | 83.3 |
| 47   | 45.0 | 13.6 | 07   | 102.4 | 31.0 | 67   | 159.8 | 48.4 | 27   | 217.2 | 65.8 | 87   | 274.7 | 83.6 |
| 48   | 45.9 | 13.9 | 08   | 103.4 | 31.3 | 68   | 160.8 | 48.7 | 28   | 218.2 | 66.1 | 88   | 275.6 | 83.9 |
| 49   | 46.9 | 14.2 | 09   | 104.3 | 31.6 | 69   | 161.7 | 49.0 | 29   | 219.2 | 66.4 | 89   | 276.6 | 84.2 |
| 50   | 47.9 | 14.5 | 10   | 105.3 | 31.9 | 70   | 162.7 | 49.3 | 30   | 220.1 | 66.7 | 90   | 277.5 | 84.5 |
| 51   | 48.8 | 14.8 | 111  | 106.2 | 32.2 | 171  | 163.6 | 49.6 | 231  | 221.1 | 67.0 | 291  | 278.5 | 84.8 |
| 52   | 49.8 | 15.1 | 12   | 107.2 | 32.5 | 72   | 164.6 | 49.9 | 32   | 222.0 | 67.3 | 92   | 279.4 | 85.1 |
| 53   | 50.7 | 15.4 | 13   | 108.1 | 32.8 | 73   | 165.6 | 50.2 | 33   | 223.0 | 67.6 | 93   | 280.4 | 85.4 |
| 54   | 51.7 | 15.7 | 14   | 109.1 | 33.1 | 74   | 166.5 | 50.5 | 34   | 223.9 | 67.9 | 94   | 281.4 | 85.7 |
| 55   | 52.6 | 16.0 | 15   | 110.1 | 33.4 | 75   | 167.5 | 50.8 | 35   | 224.9 | 68.2 | 95   | 282.3 | 86.0 |
| 56   | 53.6 | 16.2 | 16   | 111.0 | 33.6 | 76   | 168.4 | 51.0 | 36   | 225.9 | 68.4 | 96   | 283.3 | 86.3 |
| 57   | 54.5 | 16.5 | 17   | 112.0 | 33.9 | 77   | 169.4 | 51.3 | 37   | 226.8 | 68.7 | 97   | 284.2 | 86.6 |
| 58   | 55.5 | 16.8 | 18   | 112.9 | 34.2 | 78   | 170.3 | 51.6 | 38   | 227.8 | 69.0 | 98   | 285.2 | 86.9 |
| 59   | 56.5 | 17.1 | 19   | 113.9 | 34.5 | 79   | 171.3 | 51.9 | 39   | 228.7 | 69.3 | 99   | 286.1 | 87.2 |
| 60   | 57.4 | 17.4 | 20   | 114.8 | 34.8 | 80   | 172.3 | 52.2 | 40   | 229.7 | 69.6 | 300  | 287.1 | 87.5 |

Dist Dep. Lat Dist Dep. Lat Dist Dep. Lat Dist Dep. Lat Dist Dep. Lat

for 6 1/2 Points.

TABLE II. Difference of Latitude and Departure for 1  $\frac{1}{2}$  Point.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep   |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|-------|
| 1    | 00.9 | 00.3 | 61   | 57.4  | 20.5 | 121  | 113.9 | 40.8 | 181  | 170.4 | 61.0 | 241  | 226.9 | 81.2  |
| 2    | 01.9 | 00.7 | 62   | 58.4  | 20.9 | 22   | 114.9 | 41.1 | 82   | 171.4 | 61.3 | 42   | 227.8 | 81.5  |
| 3    | 02.8 | 01.0 | 63   | 59.3  | 21.2 | 23   | 115.8 | 41.4 | 83   | 172.3 | 61.6 | 43   | 228.8 | 81.8  |
| 4    | 03.8 | 01.3 | 64   | 60.3  | 21.6 | 24   | 116.7 | 41.8 | 84   | 173.2 | 62.0 | 44   | 229.7 | 82.2  |
| 5    | 04.7 | 01.7 | 65   | 61.2  | 21.9 | 25   | 117.7 | 42.1 | 85   | 174.2 | 62.3 | 45   | 230.7 | 82.5  |
| 6    | 05.6 | 02.0 | 66   | 62.1  | 22.2 | 26   | 118.6 | 42.4 | 86   | 175.1 | 62.6 | 46   | 231.6 | 82.9  |
| 7    | 06.6 | 02.4 | 67   | 63.1  | 22.6 | 27   | 119.6 | 42.8 | 87   | 176.1 | 63.0 | 47   | 232.5 | 83.2  |
| 8    | 07.5 | 02.7 | 68   | 64.0  | 22.9 | 28   | 120.5 | 43.1 | 88   | 177.0 | 63.3 | 48   | 233.5 | 83.5  |
| 9    | 08.5 | 03.0 | 69   | 65.0  | 23.2 | 29   | 121.5 | 43.4 | 89   | 177.9 | 63.7 | 49   | 234.4 | 83.9  |
| 10   | 09.4 | 03.4 | 70   | 65.9  | 23.6 | 30   | 122.4 | 43.8 | 90   | 178.9 | 64.0 | 50   | 235.4 | 84.2  |
| 11   | 10.4 | 03.7 | 71   | 66.8  | 23.9 | 131  | 123.3 | 44.1 | 191  | 179.8 | 64.3 | 251  | 236.3 | 84.5  |
| 12   | 11.3 | 04.0 | 72   | 67.8  | 24.2 | 32   | 124.3 | 44.5 | 92   | 180.8 | 64.7 | 52   | 237.3 | 84.9  |
| 13   | 12.2 | 04.4 | 73   | 68.7  | 24.6 | 33   | 125.2 | 44.8 | 93   | 181.7 | 65.0 | 53   | 238.2 | 85.2  |
| 14   | 13.2 | 04.7 | 74   | 69.7  | 24.9 | 34   | 126.2 | 45.1 | 94   | 182.6 | 65.3 | 54   | 239.1 | 85.5  |
| 15   | 14.1 | 05.1 | 75   | 70.6  | 25.3 | 35   | 127.1 | 45.5 | 95   | 183.6 | 65.7 | 55   | 240.1 | 85.9  |
| 16   | 15.1 | 05.4 | 76   | 71.6  | 25.6 | 36   | 128.0 | 45.8 | 96   | 184.5 | 66.0 | 56   | 241.0 | 86.2  |
| 17   | 16.0 | 05.7 | 77   | 72.5  | 25.9 | 37   | 129.0 | 46.1 | 97   | 185.5 | 66.3 | 57   | 242.0 | 86.6  |
| 18   | 17.0 | 06.1 | 78   | 73.4  | 26.3 | 38   | 129.9 | 46.5 | 98   | 186.4 | 66.7 | 58   | 242.9 | 86.9  |
| 19   | 17.9 | 06.4 | 79   | 74.4  | 26.6 | 39   | 130.9 | 46.8 | 99   | 187.4 | 67.0 | 59   | 243.8 | 87.2  |
| 20   | 18.8 | 06.7 | 80   | 75.3  | 26.9 | 40   | 131.8 | 47.2 | 200  | 188.3 | 67.4 | 60   | 244.8 | 87.6  |
| 21   | 19.8 | 07.1 | 81   | 76.3  | 27.3 | 141  | 132.8 | 47.5 | 201  | 189.2 | 67.7 | 261  | 245.7 | 87.9  |
| 22   | 20.7 | 07.4 | 82   | 77.2  | 27.6 | 42   | 133.7 | 47.8 | 02   | 190.2 | 68.0 | 62   | 246.7 | 88.2  |
| 23   | 21.7 | 07.7 | 83   | 78.1  | 28.0 | 43   | 134.6 | 48.2 | 03   | 191.1 | 68.4 | 63   | 247.6 | 88.6  |
| 24   | 22.6 | 08.1 | 84   | 79.1  | 28.3 | 44   | 135.6 | 48.5 | 04   | 192.1 | 68.7 | 64   | 248.6 | 88.9  |
| 25   | 23.5 | 08.4 | 85   | 80.0  | 28.6 | 45   | 136.5 | 48.8 | 05   | 193.0 | 69.0 | 65   | 249.5 | 89.2  |
| 26   | 24.5 | 08.8 | 86   | 81.0  | 29.0 | 46   | 137.5 | 49.2 | 06   | 194.0 | 69.4 | 66   | 250.4 | 89.6  |
| 27   | 25.4 | 09.1 | 87   | 81.9  | 29.3 | 47   | 138.4 | 49.5 | 07   | 194.9 | 69.7 | 67   | 251.4 | 89.9  |
| 28   | 26.4 | 09.4 | 88   | 82.8  | 29.6 | 48   | 139.3 | 49.8 | 08   | 195.8 | 70.1 | 68   | 252.3 | 90.3  |
| 29   | 27.3 | 09.8 | 89   | 83.8  | 30.0 | 49   | 140.3 | 50.2 | 09   | 196.8 | 70.4 | 69   | 253.3 | 90.6  |
| 30   | 28.2 | 10.1 | 90   | 84.7  | 30.3 | 50   | 141.2 | 50.5 | 10   | 197.7 | 70.7 | 70   | 254.2 | 90.9  |
| 31   | 29.2 | 10.4 | 91   | 85.7  | 30.6 | 151  | 142.2 | 50.9 | 211  | 198.7 | 71.1 | 271  | 255.1 | 91.3  |
| 32   | 30.1 | 10.8 | 92   | 86.6  | 31.0 | 52   | 143.1 | 51.2 | 12   | 199.6 | 71.4 | 72   | 256.1 | 91.6  |
| 33   | 31.1 | 11.1 | 93   | 87.6  | 31.3 | 53   | 144.0 | 51.5 | 13   | 200.5 | 71.7 | 73   | 257.0 | 91.9  |
| 34   | 32.0 | 11.5 | 94   | 88.5  | 31.7 | 54   | 145.0 | 51.9 | 14   | 201.5 | 72.1 | 74   | 258.0 | 92.3  |
| 35   | 33.0 | 11.8 | 95   | 89.4  | 32.0 | 55   | 145.9 | 52.2 | 15   | 202.4 | 72.4 | 75   | 258.9 | 92.6  |
| 36   | 33.9 | 12.1 | 96   | 90.4  | 32.3 | 56   | 146.9 | 52.5 | 16   | 203.4 | 72.7 | 76   | 259.9 | 93.0  |
| 37   | 34.8 | 12.5 | 97   | 91.3  | 32.7 | 57   | 147.8 | 52.9 | 17   | 204.3 | 73.1 | 77   | 260.8 | 93.3  |
| 38   | 35.8 | 12.8 | 98   | 92.3  | 33.0 | 58   | 148.8 | 53.2 | 18   | 205.2 | 73.4 | 78   | 261.7 | 93.6  |
| 39   | 36.7 | 13.1 | 99   | 93.2  | 33.3 | 59   | 149.7 | 53.6 | 19   | 206.2 | 73.8 | 79   | 262.7 | 94.0  |
| 40   | 37.7 | 13.5 | 100  | 94.2  | 33.7 | 60   | 150.6 | 53.9 | 20   | 207.1 | 74.1 | 80   | 263.6 | 94.3  |
| 41   | 38.6 | 13.8 | 101  | 95.1  | 34.0 | 161  | 151.6 | 54.2 | 221  | 208.1 | 74.4 | 281  | 264.6 | 94.6  |
| 42   | 39.5 | 14.1 | 02   | 96.0  | 34.4 | 62   | 1.2.5 | 54.6 | 22   | 209.0 | 74.8 | 82   | 265.5 | 95.0  |
| 43   | 40.5 | 14.5 | 03   | 97.0  | 34.7 | 63   | 153.5 | 54.9 | 23   | 210.0 | 75.1 | 83   | 266.4 | 95.3  |
| 44   | 41.4 | 14.8 | 04   | 97.9  | 35.0 | 64   | 154.4 | 55.2 | 24   | 210.9 | 75.4 | 84   | 267.4 | 95.6  |
| 45   | 42.4 | 15.2 | 05   | 98.9  | 35.4 | 65   | 155.3 | 55.6 | 25   | 211.8 | 75.8 | 85   | 268.3 | 96.0  |
| 46   | 43.3 | 15.5 | 06   | 99.8  | 35.7 | 66   | 156.3 | 55.9 | 26   | 212.8 | 76.1 | 86   | 269.3 | 96.3  |
| 47   | 44.3 | 15.8 | 07   | 100.8 | 36.0 | 67   | 156.2 | 56.2 | 27   | 213.7 | 76.5 | 87   | 270.2 | 96.7  |
| 48   | 45.2 | 16.2 | 08   | 101.7 | 36.4 | 68   | 158.2 | 56.6 | 28   | 214.7 | 76.8 | 88   | 271.2 | 97.0  |
| 49   | 46.1 | 16.5 | 09   | 102.7 | 36.7 | 69   | 159.1 | 56.9 | 29   | 215.6 | 77.1 | 89   | 272.1 | 97.3  |
| 50   | 47.1 | 16.8 | 10   | 103.6 | 37.0 | 70   | 160.1 | 57.3 | 30   | 216.5 | 77.5 | 90   | 273.0 | 97.7  |
| 51   | 48.0 | 17.2 | 111  | 104.5 | 37.4 | 171  | 161.0 | 57.6 | 231  | 217.5 | 77.8 | 291  | 274.0 | 98.0  |
| 52   | 49.0 | 17.5 | 12   | 105.4 | 37.7 | 72   | 161.9 | 57.9 | 32   | 218.4 | 78.1 | 92   | 274.9 | 98.3  |
| 53   | 49.9 | 17.9 | 13   | 106.4 | 38.1 | 73   | 162.9 | 58.3 | 33   | 219.4 | 78.5 | 93   | 275.9 | 98.7  |
| 54   | 50.8 | 18.2 | 14   | 107.3 | 38.4 | 74   | 163.8 | 58.6 | 34   | 220.3 | 78.8 | 94   | 276.8 | 99.0  |
| 55   | 51.8 | 18.5 | 15   | 108.3 | 38.7 | 75   | 164.8 | 58.9 | 35   | 221.3 | 79.1 | 95   | 277.7 | 99.4  |
| 56   | 52.7 | 18.9 | 16   | 109.2 | 39.1 | 76   | 165.7 | 59.3 | 36   | 222.2 | 79.5 | 96   | 278.7 | 99.7  |
| 57   | 53.7 | 19.2 | 17   | 110.2 | 39.4 | 77   | 166.6 | 59.6 | 37   | 223.1 | 79.8 | 97   | 279.6 | 100.0 |
| 58   | 54.6 | 19.5 | 18   | 111.1 | 39.7 | 78   | 167.6 | 60.0 | 38   | 224.1 | 80.2 | 98   | 280.6 | 100.4 |
| 59   | 55.5 | 19.9 | 19   | 112.0 | 40.1 | 79   | 168.5 | 60.3 | 39   | 225.0 | 80.5 | 99   | 281.5 | 100.7 |
| 60   | 56.5 | 20.2 | 20   | 113.0 | 40.4 | 80   | 169.5 | 60.6 | 40   | 226.0 | 80.8 | 300  | 282.5 | 101.0 |
| Dist | Dep. | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat.  |

for 6  $\frac{1}{4}$  Points.



TABLE II. Difference of Latitude and Departure for 2 Points.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep   | Dist | Lat.  | Dep   |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|
| 1    | 00.9 | 00.4 | 61   | 56.4  | 23.3 | 121  | 111.8 | 46.3 | 181  | 167.2 | 69.3 | 241  | 222.7 | 92.2  | 301  | 278.2 | 115.1 |
| 2    | 01.8 | 00.8 | 62   | 57.3  | 23.7 | 122  | 112.7 | 46.7 | 182  | 168.2 | 69.7 | 242  | 223.6 | 92.6  | 302  | 279.1 | 115.5 |
| 3    | 02.8 | 01.1 | 63   | 58.2  | 24.1 | 123  | 113.6 | 47.1 | 183  | 169.1 | 70.0 | 243  | 224.5 | 93.0  | 303  | 280.0 | 115.9 |
| 4    | 03.7 | 01.5 | 64   | 59.1  | 24.5 | 124  | 114.6 | 47.5 | 184  | 170.0 | 70.4 | 244  | 225.5 | 93.4  | 304  | 280.9 | 116.3 |
| 5    | 04.6 | 01.9 | 65   | 60.1  | 24.9 | 125  | 115.5 | 47.8 | 185  | 170.9 | 70.8 | 245  | 226.4 | 93.8  | 305  | 281.8 | 116.7 |
| 6    | 05.5 | 02.3 | 66   | 61.0  | 25.3 | 126  | 116.4 | 48.2 | 186  | 171.9 | 71.2 | 246  | 227.3 | 94.1  | 306  | 282.7 | 117.1 |
| 7    | 06.5 | 02.7 | 67   | 61.9  | 25.6 | 127  | 117.3 | 48.6 | 187  | 172.8 | 71.6 | 247  | 228.2 | 94.5  | 307  | 283.6 | 117.5 |
| 8    | 07.4 | 03.1 | 68   | 62.8  | 26.0 | 128  | 118.3 | 49.0 | 188  | 173.7 | 72.0 | 248  | 229.1 | 94.9  | 308  | 284.5 | 117.9 |
| 9    | 08.3 | 03.4 | 69   | 63.8  | 26.4 | 129  | 119.2 | 49.4 | 189  | 174.6 | 72.3 | 249  | 230.1 | 95.3  | 309  | 285.4 | 118.3 |
| 10   | 09.2 | 03.8 | 70   | 64.7  | 26.8 | 130  | 120.1 | 49.8 | 190  | 175.6 | 72.7 | 250  | 231.0 | 95.7  | 310  | 286.3 | 118.7 |
| 11   | 10.0 | 04.2 | 71   | 65.6  | 27.2 | 131  | 121.0 | 50.1 | 191  | 176.5 | 73.1 | 251  | 231.9 | 96.1  | 311  | 287.2 | 119.1 |
| 12   | 11.1 | 04.6 | 72   | 66.5  | 27.6 | 132  | 122.0 | 50.5 | 192  | 177.4 | 73.5 | 252  | 232.8 | 96.4  | 312  | 288.1 | 119.5 |
| 13   | 12.0 | 05.0 | 73   | 67.5  | 27.9 | 133  | 122.9 | 50.9 | 193  | 178.3 | 73.9 | 253  | 233.8 | 96.8  | 313  | 289.0 | 119.9 |
| 14   | 12.9 | 05.4 | 74   | 68.4  | 28.3 | 134  | 123.8 | 51.3 | 194  | 179.2 | 74.2 | 254  | 234.7 | 97.2  | 314  | 290.0 | 120.3 |
| 15   | 13.9 | 05.7 | 75   | 69.3  | 28.7 | 135  | 124.7 | 51.7 | 195  | 180.2 | 74.6 | 255  | 235.6 | 97.6  | 315  | 290.9 | 120.7 |
| 16   | 14.8 | 06.1 | 76   | 70.2  | 29.1 | 136  | 125.7 | 52.0 | 196  | 181.1 | 75.0 | 256  | 236.5 | 98.0  | 316  | 291.8 | 121.1 |
| 17   | 15.7 | 06.5 | 77   | 71.1  | 29.5 | 137  | 126.6 | 52.4 | 197  | 182.0 | 75.4 | 257  | 237.5 | 98.4  | 317  | 292.7 | 121.5 |
| 18   | 16.6 | 06.9 | 78   | 72.1  | 29.9 | 138  | 127.5 | 52.8 | 198  | 182.9 | 75.8 | 258  | 238.4 | 98.7  | 318  | 293.6 | 121.9 |
| 19   | 17.6 | 07.3 | 79   | 73.0  | 30.2 | 139  | 128.4 | 53.2 | 199  | 183.9 | 76.2 | 259  | 239.3 | 99.1  | 319  | 294.5 | 122.3 |
| 20   | 18.5 | 07.7 | 80   | 73.9  | 30.6 | 140  | 129.4 | 53.6 | 200  | 184.8 | 76.5 | 260  | 240.2 | 99.5  | 320  | 295.4 | 122.7 |
| 21   | 19.4 | 08.0 | 81   | 74.8  | 31.0 | 141  | 130.3 | 54.0 | 201  | 185.7 | 76.9 | 261  | 241.1 | 99.9  | 321  | 296.3 | 123.1 |
| 22   | 20.3 | 08.4 | 82   | 75.8  | 31.4 | 142  | 131.2 | 54.3 | 202  | 186.6 | 77.3 | 262  | 242.1 | 100.3 | 322  | 297.2 | 123.5 |
| 23   | 21.3 | 08.8 | 83   | 76.7  | 31.8 | 143  | 132.1 | 54.7 | 203  | 187.6 | 77.7 | 263  | 243.0 | 100.7 | 323  | 298.1 | 123.9 |
| 24   | 22.2 | 09.2 | 84   | 77.6  | 32.1 | 144  | 133.0 | 55.1 | 204  | 188.5 | 78.1 | 264  | 243.9 | 101.0 | 324  | 299.0 | 124.3 |
| 25   | 23.1 | 09.6 | 85   | 78.5  | 32.5 | 145  | 134.0 | 55.5 | 205  | 189.4 | 78.5 | 265  | 244.8 | 101.4 | 325  | 300.0 | 124.7 |
| 26   | 24.0 | 10.0 | 86   | 79.5  | 32.9 | 146  | 134.9 | 55.9 | 206  | 190.3 | 78.8 | 266  | 245.8 | 101.8 | 326  | 300.9 | 125.1 |
| 27   | 24.9 | 10.3 | 87   | 80.4  | 33.3 | 147  | 135.8 | 56.3 | 207  | 191.3 | 79.2 | 267  | 246.7 | 102.2 | 327  | 301.8 | 125.5 |
| 28   | 25.9 | 10.7 | 88   | 81.3  | 33.7 | 148  | 136.7 | 56.6 | 208  | 192.2 | 79.6 | 268  | 247.6 | 102.6 | 328  | 302.7 | 125.9 |
| 29   | 26.8 | 11.1 | 89   | 82.2  | 34.1 | 149  | 137.7 | 57.0 | 209  | 193.1 | 80.0 | 269  | 248.5 | 103.0 | 329  | 303.6 | 126.3 |
| 30   | 27.7 | 11.5 | 90   | 83.2  | 34.4 | 150  | 138.6 | 57.4 | 210  | 194.0 | 80.4 | 270  | 249.5 | 103.4 | 330  | 304.5 | 126.7 |
| 31   | 28.6 | 11.9 | 91   | 84.1  | 34.8 | 151  | 139.5 | 57.8 | 211  | 194.9 | 80.8 | 271  | 250.4 | 103.8 | 331  | 305.4 | 127.1 |
| 32   | 29.6 | 12.2 | 92   | 85.0  | 35.2 | 152  | 140.4 | 58.2 | 212  | 195.9 | 81.1 | 272  | 251.3 | 104.2 | 332  | 306.3 | 127.5 |
| 33   | 30.5 | 12.6 | 93   | 85.9  | 35.6 | 153  | 141.4 | 58.6 | 213  | 196.8 | 81.5 | 273  | 252.2 | 104.6 | 333  | 307.2 | 127.9 |
| 34   | 31.4 | 13.0 | 94   | 86.9  | 36.0 | 154  | 142.3 | 58.9 | 214  | 197.7 | 81.9 | 274  | 253.2 | 105.0 | 334  | 308.1 | 128.3 |
| 35   | 32.3 | 13.4 | 95   | 87.8  | 36.4 | 155  | 143.2 | 59.3 | 215  | 198.6 | 82.3 | 275  | 254.1 | 105.4 | 335  | 309.0 | 128.7 |
| 36   | 33.3 | 13.8 | 96   | 88.7  | 36.7 | 156  | 144.1 | 59.7 | 216  | 199.6 | 82.7 | 276  | 255.0 | 105.8 | 336  | 310.0 | 129.1 |
| 37   | 34.2 | 14.2 | 97   | 89.6  | 37.1 | 157  | 145.1 | 60.1 | 217  | 200.5 | 83.0 | 277  | 255.9 | 106.2 | 337  | 310.9 | 129.5 |
| 38   | 35.1 | 14.5 | 98   | 90.6  | 37.5 | 158  | 146.0 | 60.5 | 218  | 201.5 | 83.4 | 278  | 256.9 | 106.6 | 338  | 311.8 | 129.9 |
| 39   | 36.0 | 14.9 | 99   | 91.5  | 37.9 | 159  | 146.9 | 60.9 | 219  | 202.3 | 83.8 | 279  | 257.8 | 107.0 | 339  | 312.7 | 130.3 |
| 40   | 37.0 | 15.3 | 100  | 92.4  | 38.3 | 160  | 147.8 | 61.2 | 220  | 203.3 | 84.2 | 280  | 258.7 | 107.4 | 340  | 313.6 | 130.7 |
| 41   | 37.9 | 15.7 | 101  | 93.3  | 38.7 | 161  | 148.8 | 61.6 | 221  | 204.2 | 84.6 | 281  | 259.6 | 107.8 | 341  | 314.5 | 131.1 |
| 42   | 38.8 | 16.1 | 102  | 94.1  | 39.0 | 162  | 149.7 | 62.0 | 222  | 205.1 | 85.0 | 282  | 260.6 | 108.2 | 342  | 315.4 | 131.5 |
| 43   | 39.7 | 16.5 | 103  | 95.1  | 39.4 | 163  | 150.6 | 62.4 | 223  | 206.0 | 85.3 | 283  | 261.5 | 108.6 | 343  | 316.3 | 131.9 |
| 44   | 40.6 | 16.8 | 104  | 96.1  | 39.8 | 164  | 151.5 | 62.8 | 224  | 207.0 | 85.7 | 284  | 262.4 | 109.0 | 344  | 317.2 | 132.3 |
| 45   | 41.6 | 17.2 | 105  | 97.0  | 40.2 | 165  | 152.5 | 63.1 | 225  | 207.9 | 86.1 | 285  | 263.3 | 109.4 | 345  | 318.1 | 132.7 |
| 46   | 42.5 | 17.6 | 106  | 97.9  | 40.6 | 166  | 153.4 | 63.5 | 226  | 208.8 | 86.5 | 286  | 264.2 | 109.8 | 346  | 319.0 | 133.1 |
| 47   | 43.4 | 18.0 | 107  | 98.9  | 41.0 | 167  | 154.3 | 63.9 | 227  | 209.7 | 86.9 | 287  | 265.2 | 110.2 | 347  | 320.0 | 133.5 |
| 48   | 44.4 | 18.4 | 108  | 99.8  | 41.3 | 168  | 155.2 | 64.3 | 228  | 210.7 | 87.3 | 288  | 266.1 | 110.6 | 348  | 320.9 | 133.9 |
| 49   | 45.3 | 18.8 | 109  | 100.7 | 41.7 | 169  | 156.1 | 64.7 | 229  | 211.6 | 87.6 | 289  | 267.0 | 111.0 | 349  | 321.8 | 134.3 |
| 50   | 46.2 | 19.1 | 110  | 101.6 | 42.1 | 170  | 157.1 | 65.1 | 230  | 212.5 | 88.0 | 290  | 267.9 | 111.4 | 350  | 322.7 | 134.7 |
| 51   | 47.1 | 19.5 | 111  | 102.6 | 42.5 | 171  | 158.0 | 65.4 | 231  | 213.4 | 88.4 | 291  | 268.9 | 111.8 | 351  | 323.6 | 135.1 |
| 52   | 48.0 | 19.9 | 112  | 103.5 | 42.9 | 172  | 158.9 | 65.8 | 232  | 214.4 | 88.8 | 292  | 269.8 | 112.2 | 352  | 324.5 | 135.5 |
| 53   | 49.0 | 20.3 | 113  | 104.4 | 43.2 | 173  | 159.8 | 66.2 | 233  | 215.3 | 89.2 | 293  | 270.7 | 112.6 | 353  | 325.4 | 135.9 |
| 54   | 49.9 | 20.7 | 114  | 105.3 | 43.6 | 174  | 160.8 | 66.6 | 234  | 216.2 | 89.6 | 294  | 271.6 | 113.0 | 354  | 326.3 | 136.3 |
| 55   | 50.8 | 21.0 | 115  | 106.3 | 44.0 | 175  | 161.7 | 67.0 | 235  | 217.1 | 89.9 | 295  | 272.6 | 113.4 | 355  | 327.2 | 136.7 |
| 56   | 51.7 | 21.4 | 116  | 107.2 | 44.4 | 176  | 162.6 | 67.4 | 236  | 218.0 | 90.3 | 296  | 273.5 | 113.8 | 356  | 328.1 | 137.1 |
| 57   | 52.7 | 21.8 | 117  | 108.1 | 44.8 | 177  | 163.5 | 67.7 | 237  | 219.0 | 90.7 | 297  | 274.4 | 114.2 | 357  | 329.0 | 137.5 |
| 58   | 53.6 | 22.2 | 118  | 109.0 | 45.2 | 178  | 164.5 | 68.1 | 238  | 219.9 | 91.1 | 298  | 275.3 | 114.6 | 358  | 330.0 | 137.9 |
| 59   | 54.5 | 22.6 | 119  | 109.9 | 45.5 | 179  | 165.4 | 68.5 | 239  | 220.8 | 91.5 | 299  | 276.3 | 115.0 | 359  | 330.9 | 138.3 |
| 60   | 55.4 | 23.0 | 120  | 110.9 | 45.9 | 180  | 166.3 | 68.9 | 240  | 221.7 | 91.9 | 300  | 277.2 | 115.4 | 360  | 331.8 | 138.7 |

for 6 Points.

TABLE II. Difference of Latitude and Departure for 2  $\frac{1}{2}$  Points.

| Dist. | Lat. | Dep. | Dist. | Lat.  | Dep. | Dist. | Lat.  | Dep. | Dist. | Lat.  | Dep.  | Dist. | Lat.  | Dep.  |
|-------|------|------|-------|-------|------|-------|-------|------|-------|-------|-------|-------|-------|-------|
| 1     | 00.9 | 00.4 | 61    | 55.1  | 26.1 | 121   | 109.4 | 51.7 | 181   | 163.6 | 77.4  | 241   | 217.8 | 103.0 |
| 2     | 01.8 | 00.9 | 62    | 56.0  | 26.5 | 22    | 110.3 | 52.2 | 82    | 164.5 | 77.8  | 42    | 218.7 | 103.5 |
| 3     | 02.7 | 01.3 | 63    | 57.0  | 26.9 | 23    | 111.2 | 52.6 | 83    | 165.4 | 78.2  | 43    | 219.6 | 103.9 |
| 4     | 03.6 | 01.7 | 64    | 57.9  | 27.4 | 24    | 112.1 | 53.0 | 84    | 166.3 | 78.7  | 44    | 220.5 | 104.3 |
| 5     | 04.5 | 02.1 | 65    | 58.8  | 27.8 | 25    | 113.0 | 53.5 | 85    | 167.2 | 79.1  | 45    | 221.4 | 104.8 |
| 6     | 05.4 | 02.6 | 66    | 59.7  | 28.2 | 26    | 113.9 | 53.9 | 86    | 168.1 | 79.5  | 46    | 222.4 | 105.2 |
| 7     | 06.3 | 03.0 | 67    | 60.6  | 28.6 | 27    | 114.8 | 54.3 | 87    | 169.0 | 80.0  | 47    | 223.3 | 105.6 |
| 8     | 07.2 | 03.4 | 68    | 61.5  | 29.1 | 28    | 115.7 | 54.7 | 88    | 169.9 | 80.4  | 48    | 224.2 | 106.0 |
| 9     | 08.1 | 03.8 | 69    | 62.4  | 29.5 | 29    | 116.6 | 55.2 | 89    | 170.8 | 80.8  | 49    | 225.1 | 106.5 |
| 10    | 09.0 | 04.3 | 70    | 63.3  | 29.9 | 30    | 117.5 | 55.6 | 90    | 171.7 | 81.2  | 50    | 226.0 | 106.9 |
| 11    | 09.9 | 04.7 | 71    | 64.2  | 30.4 | 131   | 118.4 | 56.0 | 191   | 172.6 | 81.7  | 251   | 226.9 | 107.3 |
| 12    | 10.8 | 05.1 | 72    | 65.1  | 30.8 | 32    | 119.3 | 56.4 | 92    | 173.6 | 82.1  | 52    | 227.8 | 107.8 |
| 13    | 11.8 | 05.6 | 73    | 66.0  | 31.2 | 33    | 120.2 | 56.9 | 93    | 174.5 | 82.5  | 53    | 228.7 | 108.2 |
| 14    | 12.7 | 06.0 | 74    | 66.9  | 31.6 | 34    | 121.1 | 57.3 | 94    | 175.4 | 83.0  | 54    | 229.6 | 108.6 |
| 15    | 13.6 | 06.4 | 75    | 67.8  | 32.1 | 35    | 122.0 | 57.7 | 95    | 176.3 | 83.4  | 55    | 230.5 | 109.0 |
| 16    | 14.5 | 06.8 | 76    | 68.7  | 32.5 | 36    | 122.9 | 58.2 | 96    | 177.2 | 83.8  | 56    | 231.4 | 109.5 |
| 17    | 15.4 | 07.3 | 77    | 69.6  | 32.9 | 37    | 123.8 | 58.6 | 97    | 178.1 | 84.2  | 57    | 232.3 | 109.9 |
| 18    | 16.3 | 07.7 | 78    | 70.5  | 33.4 | 38    | 124.7 | 59.0 | 98    | 179.0 | 84.7  | 58    | 233.2 | 110.3 |
| 19    | 17.2 | 08.1 | 79    | 71.4  | 33.8 | 39    | 125.6 | 59.4 | 99    | 179.9 | 85.1  | 59    | 234.1 | 110.7 |
| 20    | 18.1 | 08.6 | 80    | 72.3  | 34.2 | 40    | 126.5 | 59.9 | 100   | 180.8 | 85.5  | 60    | 235.0 | 111.2 |
| 21    | 19.0 | 09.0 | 81    | 73.2  | 34.6 | 141   | 127.4 | 60.3 | 201   | 181.7 | 85.9  | 261   | 235.9 | 111.6 |
| 22    | 19.9 | 09.4 | 82    | 74.1  | 35.1 | 42    | 128.4 | 60.7 | 02    | 182.6 | 86.4  | 62    | 236.8 | 112.0 |
| 23    | 20.8 | 09.8 | 83    | 75.0  | 35.5 | 43    | 129.3 | 61.1 | 03    | 183.5 | 86.8  | 63    | 237.7 | 112.5 |
| 24    | 21.7 | 10.3 | 84    | 75.9  | 35.9 | 44    | 130.2 | 61.6 | 04    | 184.4 | 87.2  | 64    | 238.6 | 112.9 |
| 25    | 22.6 | 10.7 | 85    | 76.8  | 36.3 | 45    | 131.1 | 62.0 | 05    | 185.3 | 87.7  | 65    | 239.5 | 113.3 |
| 26    | 23.5 | 11.1 | 86    | 77.7  | 36.8 | 46    | 132.0 | 62.4 | 06    | 186.2 | 88.1  | 66    | 240.4 | 113.7 |
| 27    | 24.4 | 11.5 | 87    | 78.6  | 37.2 | 47    | 132.9 | 62.9 | 07    | 187.1 | 88.5  | 67    | 241.3 | 114.2 |
| 28    | 25.3 | 12.0 | 88    | 79.6  | 37.6 | 48    | 133.8 | 63.3 | 08    | 188.0 | 88.9  | 68    | 242.2 | 114.6 |
| 29    | 26.2 | 12.4 | 89    | 80.5  | 38.1 | 49    | 134.7 | 63.7 | 09    | 188.9 | 89.4  | 69    | 243.1 | 115.0 |
| 30    | 27.1 | 12.8 | 90    | 81.4  | 38.5 | 50    | 135.6 | 64.1 | 10    | 189.8 | 89.8  | 70    | 244.0 | 115.5 |
| 31    | 28.0 | 13.3 | 91    | 82.3  | 38.9 | 151   | 136.5 | 64.6 | 211   | 190.7 | 90.2  | 271   | 245.0 | 115.9 |
| 32    | 28.9 | 13.7 | 92    | 83.2  | 39.3 | 52    | 137.4 | 65.0 | 12    | 191.6 | 90.6  | 72    | 245.9 | 116.3 |
| 33    | 29.8 | 14.1 | 93    | 84.1  | 39.8 | 53    | 138.3 | 65.4 | 13    | 192.5 | 91.1  | 73    | 246.8 | 116.7 |
| 34    | 30.7 | 14.5 | 94    | 85.0  | 40.2 | 54    | 139.2 | 65.8 | 14    | 193.4 | 91.5  | 74    | 247.7 | 117.2 |
| 35    | 31.6 | 15.0 | 95    | 85.9  | 40.6 | 55    | 140.1 | 66.3 | 15    | 194.3 | 91.9  | 75    | 248.6 | 117.6 |
| 36    | 32.5 | 15.4 | 96    | 86.8  | 41.0 | 56    | 141.0 | 66.7 | 16    | 195.2 | 92.4  | 76    | 249.5 | 118.0 |
| 37    | 33.4 | 15.8 | 97    | 87.7  | 41.5 | 57    | 141.9 | 67.1 | 17    | 196.1 | 92.8  | 77    | 250.4 | 118.4 |
| 38    | 34.4 | 16.2 | 98    | 88.6  | 41.9 | 58    | 142.8 | 67.6 | 18    | 197.0 | 93.2  | 78    | 251.3 | 118.9 |
| 39    | 35.3 | 16.7 | 99    | 89.5  | 42.3 | 59    | 143.7 | 68.0 | 19    | 197.9 | 93.6  | 79    | 252.2 | 119.3 |
| 40    | 36.2 | 17.1 | 100   | 90.4  | 42.8 | 60    | 144.6 | 68.4 | 20    | 198.8 | 94.1  | 80    | 253.1 | 119.7 |
| 41    | 37.1 | 17.5 | 101   | 91.3  | 43.2 | 161   | 145.5 | 68.8 | 221   | 199.8 | 94.5  | 281   | 254.0 | 120.2 |
| 42    | 38.0 | 18.0 | 02    | 92.2  | 43.6 | 62    | 146.4 | 69.3 | 22    | 200.7 | 94.9  | 82    | 254.9 | 120.6 |
| 43    | 38.9 | 18.4 | 03    | 93.1  | 44.0 | 63    | 147.3 | 69.7 | 23    | 201.6 | 95.4  | 83    | 255.8 | 121.0 |
| 44    | 39.8 | 18.8 | 04    | 94.0  | 44.5 | 64    | 148.2 | 70.1 | 24    | 202.5 | 95.8  | 84    | 256.7 | 121.4 |
| 45    | 40.7 | 19.2 | 05    | 94.9  | 44.9 | 65    | 149.1 | 70.6 | 25    | 203.4 | 96.2  | 85    | 257.6 | 121.9 |
| 46    | 41.6 | 19.7 | 06    | 95.8  | 45.3 | 66    | 150.0 | 71.0 | 26    | 204.3 | 96.6  | 86    | 258.5 | 122.3 |
| 47    | 42.5 | 20.1 | 07    | 96.7  | 45.8 | 67    | 151.0 | 71.4 | 27    | 205.2 | 97.1  | 87    | 259.4 | 122.7 |
| 48    | 43.4 | 20.5 | 08    | 97.6  | 46.2 | 68    | 151.9 | 71.8 | 28    | 206.1 | 97.5  | 88    | 260.3 | 123.1 |
| 49    | 44.3 | 21.0 | 09    | 98.5  | 46.6 | 69    | 152.8 | 72.3 | 29    | 207.0 | 97.9  | 89    | 261.2 | 123.6 |
| 50    | 45.2 | 21.4 | 10    | 99.4  | 47.0 | 70    | 153.7 | 72.7 | 30    | 207.9 | 98.3  | 90    | 262.1 | 124.0 |
| 51    | 46.1 | 21.8 | 111   | 100.3 | 47.5 | 171   | 154.6 | 73.1 | 231   | 208.8 | 98.8  | 291   | 263.0 | 124.4 |
| 52    | 47.0 | 22.2 | 12    | 101.2 | 47.9 | 72    | 155.5 | 73.5 | 32    | 209.7 | 99.2  | 92    | 263.9 | 124.9 |
| 53    | 47.9 | 22.7 | 13    | 102.1 | 48.3 | 73    | 156.4 | 74.0 | 33    | 210.6 | 99.6  | 93    | 264.8 | 125.3 |
| 54    | 48.8 | 23.1 | 14    | 103.0 | 48.7 | 74    | 157.3 | 74.4 | 34    | 211.5 | 100.1 | 94    | 265.7 | 125.7 |
| 55    | 49.7 | 23.5 | 15    | 103.9 | 49.2 | 75    | 158.2 | 74.8 | 35    | 212.4 | 100.5 | 95    | 266.6 | 126.1 |
| 56    | 50.6 | 23.9 | 16    | 104.8 | 49.6 | 76    | 159.1 | 75.3 | 36    | 213.3 | 100.9 | 96    | 267.5 | 126.6 |
| 57    | 51.5 | 24.4 | 17    | 105.8 | 50.0 | 77    | 160.0 | 75.7 | 37    | 214.2 | 101.3 | 97    | 268.4 | 127.0 |
| 58    | 52.4 | 24.8 | 18    | 106.7 | 50.5 | 78    | 160.9 | 76.1 | 38    | 215.1 | 101.8 | 98    | 269.3 | 127.4 |
| 59    | 53.3 | 25.2 | 19    | 107.6 | 50.9 | 79    | 161.8 | 76.5 | 39    | 216.0 | 102.2 | 99    | 270.2 | 127.8 |
| 60    | 54.2 | 25.7 | 20    | 108.5 | 51.3 | 80    | 162.7 | 77.0 | 40    | 216.9 | 102.6 | 300   | 271.2 | 128.3 |

for 5  $\frac{3}{4}$  Points.

TABLE II. Difference of Latitude and Departure for 2 1/2 Points.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep   |
|------|------|------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|
| 1    | 00.9 | 00.5 | 61   | 53.8  | 28.7 | 121  | 106.7 | 57.0 | 181  | 159.6 | 85.3  | 241  | 212.6 | 113.0 |
| 2    | 01.8 | 00.9 | 62   | 54.7  | 29.2 | 22   | 107.6 | 57.5 | 82   | 160.5 | 85.8  | 42   | 213.4 | 114.0 |
| 3    | 02.6 | 01.4 | 63   | 55.6  | 29.7 | 23   | 108.5 | 58.0 | 83   | 161.4 | 86.2  | 43   | 214.3 | 114.5 |
| 4    | 03.5 | 01.9 | 64   | 56.4  | 30.2 | 24   | 109.4 | 58.4 | 84   | 162.3 | 86.7  | 44   | 215.2 | 115.0 |
| 5    | 04.4 | 02.4 | 65   | 57.3  | 30.6 | 25   | 110.3 | 58.9 | 85   | 163.2 | 87.2  | 45   | 216.1 | 115.5 |
| 6    | 05.3 | 02.8 | 66   | 58.2  | 31.1 | 26   | 111.2 | 59.4 | 86   | 164.1 | 87.6  | 46   | 217.0 | 116.0 |
| 7    | 06.2 | 03.3 | 67   | 59.1  | 31.6 | 27   | 112.1 | 59.8 | 87   | 164.9 | 88.1  | 47   | 217.9 | 116.5 |
| 8    | 07.1 | 03.8 | 68   | 60.0  | 32.0 | 28   | 112.9 | 60.3 | 88   | 165.8 | 88.6  | 48   | 218.8 | 117.0 |
| 9    | 07.9 | 04.2 | 69   | 60.9  | 32.5 | 29   | 113.8 | 60.8 | 89   | 166.7 | 89.1  | 49   | 219.6 | 117.5 |
| 10   | 08.8 | 04.7 | 70   | 61.7  | 33.0 | 30   | 114.7 | 61.3 | 90   | 167.6 | 89.5  | 50   | 220.5 | 118.0 |
| 11   | 09.7 | 05.2 | 71   | 62.6  | 33.5 | 131  | 115.5 | 61.7 | 191  | 168.5 | 90.0  | 251  | 221.4 | 118.5 |
| 12   | 10.6 | 05.7 | 72   | 63.5  | 33.9 | 32   | 116.4 | 62.2 | 92   | 169.3 | 90.5  | 52   | 222.3 | 119.0 |
| 13   | 11.5 | 06.1 | 73   | 64.4  | 34.4 | 33   | 117.3 | 62.7 | 93   | 170.2 | 90.9  | 53   | 223.1 | 119.5 |
| 14   | 12.3 | 06.6 | 74   | 65.3  | 34.9 | 34   | 118.2 | 63.1 | 94   | 171.1 | 91.4  | 54   | 224.0 | 120.0 |
| 15   | 13.2 | 07.1 | 75   | 66.2  | 35.3 | 35   | 119.1 | 63.6 | 95   | 172.0 | 91.9  | 55   | 224.9 | 120.5 |
| 16   | 14.1 | 07.5 | 76   | 67.0  | 35.8 | 36   | 120.0 | 64.5 | 96   | 172.9 | 92.4  | 56   | 225.8 | 121.0 |
| 17   | 15.0 | 08.0 | 77   | 67.9  | 36.3 | 37   | 120.8 | 64.6 | 97   | 173.8 | 92.8  | 57   | 226.7 | 121.5 |
| 18   | 15.9 | 08.5 | 78   | 68.8  | 36.8 | 38   | 121.7 | 65.0 | 98   | 174.6 | 93.3  | 58   | 227.6 | 122.0 |
| 19   | 16.8 | 09.0 | 79   | 69.7  | 37.2 | 39   | 122.6 | 65.5 | 99   | 175.5 | 93.8  | 59   | 228.4 | 122.5 |
| 20   | 17.6 | 09.4 | 80   | 70.6  | 37.7 | 40   | 123.5 | 66.0 | 200  | 176.4 | 94.2  | 60   | 229.3 | 123.0 |
| 21   | 18.5 | 09.9 | 81   | 71.4  | 38.2 | 141  | 124.4 | 66.4 | 201  | 177.3 | 94.7  | 261  | 230.2 | 123.5 |
| 22   | 19.4 | 10.4 | 82   | 72.3  | 38.6 | 42   | 125.2 | 66.9 | 02   | 178.2 | 95.2  | 62   | 231.1 | 124.0 |
| 23   | 20.3 | 10.8 | 83   | 73.2  | 39.1 | 43   | 126.1 | 67.4 | 03   | 179.0 | 95.6  | 63   | 232.0 | 124.5 |
| 24   | 21.2 | 11.3 | 84   | 74.1  | 39.6 | 44   | 127.0 | 67.8 | 04   | 179.9 | 96.1  | 64   | 232.8 | 125.0 |
| 25   | 22.1 | 11.8 | 85   | 75.0  | 40.1 | 45   | 127.9 | 68.3 | 05   | 180.0 | 96.6  | 65   | 233.7 | 125.5 |
| 26   | 22.9 | 12.3 | 86   | 75.9  | 40.5 | 46   | 128.8 | 68.8 | 06   | 181.7 | 97.1  | 66   | 234.6 | 126.0 |
| 27   | 23.8 | 12.7 | 87   | 76.7  | 41.0 | 47   | 129.6 | 69.3 | 07   | 182.6 | 97.5  | 67   | 235.5 | 126.5 |
| 28   | 24.7 | 13.2 | 88   | 77.6  | 41.5 | 48   | 130.5 | 69.7 | 08   | 183.5 | 98.0  | 68   | 236.4 | 127.0 |
| 29   | 25.6 | 13.7 | 89   | 78.5  | 41.9 | 49   | 131.4 | 70.2 | 09   | 184.3 | 98.5  | 69   | 237.3 | 127.5 |
| 30   | 26.5 | 14.1 | 90   | 79.4  | 42.4 | 5    | 132.3 | 70.7 | 10   | 185.2 | 98.9  | 70   | 238.1 | 128.0 |
| 31   | 27.3 | 14.6 | 91   | 80.3  | 42.9 | 151  | 133.2 | 71.1 | 211  | 186.1 | 99.4  | 271  | 239.0 | 128.5 |
| 32   | 28.2 | 15.1 | 92   | 81.1  | 43.4 | 52   | 134.1 | 71.6 | 12   | 187.0 | 99.9  | 72   | 239.9 | 129.0 |
| 33   | 29.1 | 15.5 | 93   | 82.0  | 43.8 | 53   | 134.9 | 72.1 | 13   | 187.9 | 100.4 | 73   | 240.8 | 129.5 |
| 34   | 30.0 | 16.0 | 94   | 82.9  | 44.3 | 54   | 135.8 | 72.6 | 14   | 188.7 | 100.8 | 74   | 241.7 | 130.0 |
| 35   | 30.9 | 16.5 | 95   | 83.8  | 44.8 | 55   | 136.7 | 73.0 | 15   | 189.6 | 101.3 | 75   | 242.5 | 130.5 |
| 36   | 31.8 | 17.0 | 96   | 84.7  | 45.2 | 56   | 137.6 | 73.5 | 16   | 190.5 | 101.8 | 76   | 243.4 | 131.0 |
| 37   | 32.6 | 17.4 | 97   | 85.6  | 45.7 | 57   | 138.5 | 74.0 | 17   | 191.4 | 102.2 | 77   | 244.3 | 131.5 |
| 38   | 33.5 | 17.9 | 98   | 86.4  | 46.2 | 58   | 139.4 | 74.4 | 18   | 192.3 | 102.7 | 78   | 245.2 | 132.0 |
| 39   | 34.4 | 18.4 | 99   | 87.3  | 46.6 | 59   | 140.2 | 74.9 | 19   | 193.2 | 103.2 | 79   | 246.1 | 132.5 |
| 40   | 35.3 | 18.8 | 100  | 88.2  | 47.1 | 60   | 141.1 | 75.4 | 20   | 194.0 | 103.7 | 80   | 247.0 | 133.0 |
| 41   | 36.2 | 19.3 | 101  | 89.1  | 47.6 | 161  | 142.0 | 75.9 | 211  | 194.9 | 104.1 | 281  | 247.8 | 133.5 |
| 42   | 37.0 | 19.8 | 02   | 90.0  | 48.1 | 62   | 142.9 | 76.3 | 22   | 195.8 | 104.6 | 82   | 248.7 | 134.0 |
| 43   | 37.9 | 20.3 | 03   | 90.8  | 48.5 | 63   | 143.8 | 76.8 | 23   | 196.7 | 105.1 | 83   | 249.6 | 134.5 |
| 44   | 38.8 | 20.7 | 04   | 91.7  | 49.0 | 64   | 144.6 | 77.3 | 24   | 197.6 | 105.5 | 84   | 250.5 | 135.0 |
| 45   | 39.7 | 21.2 | 05   | 92.6  | 49.5 | 65   | 145.5 | 77.7 | 25   | 198.4 | 106.0 | 85   | 251.4 | 135.5 |
| 46   | 40.6 | 21.7 | 06   | 93.5  | 49.9 | 66   | 146.4 | 78.2 | 26   | 199.3 | 106.5 | 86   | 252.3 | 136.0 |
| 47   | 41.5 | 22.1 | 07   | 94.4  | 50.4 | 67   | 147.3 | 78.7 | 27   | 200.2 | 107.0 | 87   | 253.1 | 136.5 |
| 48   | 42.3 | 22.6 | 08   | 95.3  | 50.9 | 68   | 148.2 | 79.2 | 28   | 201.1 | 107.4 | 88   | 254.0 | 137.0 |
| 49   | 43.2 | 23.1 | 09   | 96.1  | 51.4 | 69   | 149.1 | 79.6 | 29   | 202.0 | 107.9 | 89   | 254.9 | 137.5 |
| 50   | 44.1 | 23.6 | 10   | 97.0  | 51.8 | 70   | 149.9 | 80.1 | 30   | 202.9 | 108.4 | 90   | 255.8 | 138.0 |
| 51   | 45.0 | 24.0 | 111  | 97.9  | 52.3 | 171  | 150.8 | 80.6 | 231  | 203.7 | 108.8 | 291  | 256.7 | 138.5 |
| 52   | 45.9 | 24.5 | 12   | 98.8  | 52.8 | 72   | 151.7 | 81.0 | 32   | 204.6 | 109.3 | 92   | 257.5 | 139.0 |
| 53   | 46.7 | 25.0 | 13   | 99.7  | 53.2 | 73   | 152.6 | 81.5 | 33   | 205.5 | 109.8 | 93   | 258.4 | 139.5 |
| 54   | 47.6 | 25.4 | 14   | 100.5 | 53.7 | 74   | 153.5 | 82.0 | 34   | 206.4 | 110.3 | 94   | 259.3 | 140.0 |
| 55   | 48.5 | 25.9 | 15   | 101.4 | 54.2 | 75   | 154.3 | 82.5 | 35   | 207.3 | 110.7 | 95   | 260.2 | 140.5 |
| 56   | 49.4 | 26.4 | 16   | 102.3 | 54.7 | 76   | 155.2 | 82.9 | 36   | 208.2 | 111.2 | 96   | 261.1 | 141.0 |
| 57   | 50.3 | 26.9 | 17   | 103.2 | 55.1 | 77   | 156.1 | 83.4 | 37   | 209.0 | 111.7 | 97   | 262.0 | 141.5 |
| 58   | 51.2 | 27.3 | 18   | 104.1 | 55.6 | 78   | 157.0 | 83.9 | 38   | 209.9 | 112.1 | 98   | 262.8 | 142.0 |
| 59   | 52.0 | 27.8 | 19   | 105.0 | 56.1 | 79   | 157.9 | 84.3 | 39   | 210.8 | 112.6 | 99   | 263.7 | 142.5 |
| 60   | 52.9 | 28.3 | 20   | 105.8 | 56.5 | 80   | 158.8 | 84.8 | 40   | 211.7 | 113.1 | 300  | 264.6 | 143.0 |
| Dist | Dep. | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  |

for 5 1/2 Points.



TABLE II. Difference of Latitude and Departure for 2  $\frac{1}{2}$  Points.

| Dep. | Lat. | Dep. | Lat. | Dep.  | Lat. | Dep. | Lat.  | Dep. | Lat. | Dep.  | Lat.  | Dep. | Lat.  | Dep.  |
|------|------|------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|
| 113. | 00.9 | 00.6 | 61   | 52.3  | 31.4 | 121  | 103.8 | 62.2 | 181  | 155.2 | 93.0  | 241  | 206.7 | 123.9 |
| 114. | 01.7 | 01.0 | 62   | 53.2  | 31.9 | 22   | 104.6 | 62.7 | 82   | 156.1 | 93.5  | 42   | 207.6 | 124.4 |
| 114. | 02.6 | 01.5 | 63   | 54.0  | 32.4 | 23   | 105.5 | 63.2 | 83   | 157.0 | 94.0  | 43   | 208.4 | 124.9 |
| 115. | 03.4 | 02.1 | 64   | 54.9  | 32.9 | 24   | 106.4 | 63.7 | 84   | 157.8 | 94.6  | 44   | 209.3 | 125.4 |
| 115. | 04.3 | 02.6 | 65   | 55.8  | 33.4 | 25   | 107.2 | 64.2 | 85   | 158.7 | 95.1  | 45   | 210.1 | 125.9 |
| 115. | 05.1 | 03.1 | 66   | 56.6  | 33.9 | 26   | 108.1 | 64.8 | 86   | 159.5 | 95.6  | 46   | 211.0 | 126.4 |
| 116. | 06.0 | 03.6 | 67   | 57.5  | 34.4 | 27   | 108.9 | 65.3 | 87   | 160.4 | 96.1  | 47   | 211.9 | 126.9 |
| 116. | 06.9 | 04.1 | 68   | 58.3  | 35.0 | 28   | 109.8 | 65.8 | 88   | 161.2 | 96.6  | 48   | 212.7 | 127.4 |
| 117. | 07.7 | 04.6 | 69   | 59.2  | 35.5 | 29   | 110.6 | 66.3 | 89   | 162.1 | 97.1  | 49   | 213.6 | 128.0 |
| 117. | 08.6 | 05.1 | 70   | 60.0  | 36.0 | 30   | 111.5 | 66.8 | 90   | 163.0 | 97.6  | 50   | 214.4 | 128.5 |
| 118. | 09.4 | 05.7 | 71   | 60.9  | 36.5 | 31   | 112.4 | 67.3 | 191  | 163.8 | 98.2  | 251  | 215.3 | 129.0 |
| 118. | 10.3 | 06.2 | 72   | 61.8  | 37.0 | 32   | 113.2 | 67.8 | 92   | 164.7 | 98.7  | 52   | 216.1 | 129.5 |
| 119. | 11.2 | 06.7 | 73   | 62.6  | 37.6 | 33   | 114.1 | 68.4 | 93   | 165.5 | 99.2  | 53   | 217.0 | 130.0 |
| 119. | 12.0 | 07.2 | 74   | 63.5  | 38.1 | 34   | 114.9 | 68.9 | 94   | 166.4 | 99.7  | 54   | 217.9 | 130.5 |
| 120. | 12.9 | 07.7 | 75   | 64.3  | 38.6 | 35   | 115.8 | 69.4 | 95   | 167.3 | 100.2 | 55   | 218.7 | 131.0 |
| 120. | 13.7 | 08.2 | 76   | 65.2  | 39.1 | 36   | 116.6 | 69.9 | 96   | 168.1 | 100.7 | 56   | 219.6 | 131.5 |
| 121. | 14.6 | 08.7 | 77   | 66.0  | 39.6 | 37   | 117.5 | 70.4 | 97   | 169.0 | 101.2 | 57   | 220.4 | 132.1 |
| 121. | 15.4 | 09.3 | 78   | 66.9  | 40.1 | 38   | 118.4 | 70.9 | 98   | 169.8 | 101.8 | 58   | 221.3 | 132.6 |
| 122. | 16.3 | 09.8 | 79   | 67.8  | 40.6 | 39   | 119.2 | 71.4 | 99   | 170.7 | 102.3 | 59   | 222.1 | 133.1 |
| 122. | 17.2 | 10.3 | 80   | 68.6  | 41.1 | 40   | 120.1 | 72.0 | 200  | 171.5 | 102.8 | 60   | 223.0 | 133.6 |
| 123. | 18.0 | 10.8 | 81   | 69.5  | 41.6 | 41   | 120.9 | 72.5 | 201  | 172.4 | 103.3 | 261  | 223.9 | 134.1 |
| 123. | 18.9 | 11.3 | 82   | 70.3  | 42.2 | 42   | 121.8 | 73.0 | 02   | 173.3 | 103.8 | 62   | 224.7 | 134.6 |
| 123. | 19.7 | 11.8 | 83   | 71.2  | 42.7 | 43   | 122.7 | 73.5 | 03   | 174.1 | 104.3 | 63   | 225.6 | 135.1 |
| 124. | 20.6 | 12.3 | 84   | 72.0  | 43.2 | 44   | 123.5 | 74.0 | 04   | 175.0 | 104.8 | 64   | 226.4 | 135.7 |
| 124. | 21.4 | 12.9 | 85   | 72.9  | 43.7 | 45   | 124.4 | 74.6 | 05   | 175.8 | 105.4 | 65   | 227.3 | 136.2 |
| 125. | 22.3 | 13.4 | 86   | 73.8  | 44.2 | 46   | 125.2 | 75.1 | 06   | 176.7 | 105.9 | 66   | 228.1 | 136.7 |
| 125. | 23.2 | 13.9 | 87   | 74.6  | 44.7 | 47   | 126.1 | 75.6 | 07   | 177.5 | 106.4 | 67   | 229.0 | 137.2 |
| 126. | 24.0 | 14.4 | 88   | 75.5  | 45.2 | 48   | 126.9 | 76.1 | 08   | 178.4 | 106.9 | 68   | 229.9 | 137.7 |
| 126. | 24.9 | 14.9 | 89   | 76.3  | 45.7 | 49   | 127.8 | 76.6 | 09   | 179.3 | 107.4 | 69   | 230.7 | 138.2 |
| 127. | 25.7 | 15.4 | 90   | 77.2  | 46.3 | 50   | 128.7 | 77.1 | 10   | 180.1 | 107.9 | 70   | 231.6 | 138.8 |
| 127. | 26.6 | 15.9 | 91   | 78.1  | 46.8 | 151  | 129.5 | 77.6 | 211  | 181.0 | 108.4 | 271  | 232.4 | 139.3 |
| 128. | 27.4 | 16.4 | 92   | 78.9  | 47.3 | 52   | 130.4 | 78.1 | 12   | 181.8 | 109.0 | 72   | 233.3 | 139.8 |
| 128. | 28.3 | 17.0 | 93   | 79.8  | 47.8 | 53   | 131.2 | 78.6 | 13   | 182.7 | 109.5 | 73   | 234.2 | 140.3 |
| 129. | 29.2 | 17.5 | 94   | 80.6  | 48.3 | 54   | 132.1 | 79.1 | 14   | 183.5 | 110.0 | 74   | 235.0 | 140.8 |
| 129. | 30.0 | 18.0 | 95   | 81.5  | 48.8 | 55   | 132.9 | 79.7 | 15   | 184.4 | 110.5 | 75   | 235.9 | 141.3 |
| 130. | 30.9 | 18.5 | 96   | 82.3  | 49.3 | 56   | 133.8 | 80.2 | 16   | 185.3 | 111.0 | 76   | 236.7 | 141.8 |
| 130. | 31.7 | 19.0 | 97   | 83.2  | 49.9 | 57   | 134.7 | 80.7 | 17   | 186.1 | 111.5 | 77   | 237.6 | 142.4 |
| 131. | 32.6 | 19.5 | 98   | 84.1  | 50.4 | 58   | 135.5 | 81.2 | 18   | 187.0 | 112.0 | 78   | 238.4 | 142.9 |
| 131. | 33.5 | 20.0 | 99   | 84.9  | 50.9 | 59   | 136.4 | 81.7 | 19   | 187.8 | 112.6 | 79   | 239.3 | 143.4 |
| 131. | 34.3 | 20.6 | 100  | 85.8  | 51.4 | 60   | 137.2 | 82.2 | 20   | 188.7 | 113.1 | 80   | 240.2 | 143.9 |
| 132. | 35.2 | 21.1 | 101  | 86.6  | 51.9 | 161  | 138.1 | 82.7 | 221  | 189.6 | 113.6 | 281  | 241.0 | 144.4 |
| 132. | 36.0 | 21.6 | 02   | 87.5  | 52.4 | 62   | 138.9 | 83.3 | 22   | 190.4 | 114.1 | 82   | 241.9 | 144.9 |
| 133. | 36.9 | 22.1 | 03   | 88.3  | 52.9 | 63   | 139.8 | 83.8 | 23   | 191.3 | 114.6 | 83   | 242.7 | 145.4 |
| 133. | 37.7 | 22.6 | 04   | 89.2  | 53.4 | 64   | 140.7 | 84.3 | 24   | 192.1 | 115.1 | 84   | 243.6 | 146.0 |
| 134. | 38.6 | 23.1 | 05   | 90.1  | 54.0 | 65   | 141.5 | 84.8 | 25   | 193.0 | 115.6 | 85   | 244.4 | 146.5 |
| 134. | 39.5 | 23.6 | 06   | 90.9  | 54.5 | 66   | 142.4 | 85.3 | 26   | 193.8 | 116.1 | 86   | 245.3 | 147.0 |
| 135. | 40.3 | 24.2 | 07   | 91.8  | 55.0 | 67   | 143.2 | 85.8 | 27   | 194.7 | 116.7 | 87   | 246.2 | 147.5 |
| 135. | 41.2 | 24.7 | 08   | 92.6  | 55.5 | 68   | 144.1 | 86.3 | 28   | 195.6 | 117.2 | 88   | 247.0 | 148.0 |
| 136. | 42.0 | 25.2 | 09   | 93.5  | 56.0 | 69   | 145.0 | 86.9 | 29   | 196.4 | 117.7 | 89   | 247.9 | 148.5 |
| 136. | 42.9 | 25.7 | 10   | 94.3  | 56.5 | 70   | 145.8 | 87.4 | 30   | 197.3 | 118.2 | 90   | 248.7 | 149.0 |
| 137. | 43.7 | 26.2 | 111  | 95.2  | 57.0 | 171  | 146.7 | 87.9 | 231  | 198.1 | 118.7 | 291  | 249.6 | 149.6 |
| 137. | 44.6 | 26.7 | 12   | 96.1  | 57.6 | 72   | 147.5 | 88.4 | 32   | 199.0 | 119.2 | 92   | 250.4 | 150.1 |
| 138. | 45.5 | 27.2 | 13   | 96.9  | 58.1 | 73   | 148.4 | 88.9 | 33   | 199.8 | 119.7 | 93   | 251.3 | 150.6 |
| 138. | 46.3 | 27.8 | 14   | 97.8  | 58.6 | 74   | 149.2 | 89.4 | 34   | 200.7 | 120.3 | 94   | 252.2 | 151.1 |
| 139. | 47.2 | 28.3 | 15   | 98.6  | 59.1 | 75   | 150.1 | 89.9 | 35   | 201.6 | 120.8 | 95   | 253.0 | 151.6 |
| 139. | 48.0 | 28.8 | 16   | 99.5  | 59.6 | 76   | 151.0 | 90.4 | 36   | 202.4 | 121.3 | 96   | 253.9 | 152.1 |
| 139. | 48.9 | 29.3 | 17   | 100.4 | 60.1 | 77   | 151.8 | 91.0 | 37   | 203.3 | 121.8 | 97   | 254.7 | 152.6 |
| 140. | 49.7 | 29.8 | 18   | 101.2 | 60.6 | 78   | 152.7 | 91.5 | 38   | 204.1 | 122.3 | 98   | 255.6 | 153.1 |
| 140. | 50.6 | 30.3 | 19   | 102.1 | 61.2 | 79   | 153.5 | 92.0 | 39   | 205.0 | 122.8 | 99   | 256.5 | 153.7 |
| 141. | 51.5 | 30.8 | 20   | 102.9 | 61.7 | 180  | 154.4 | 92.5 | 140  | 205.8 | 123.3 | 300  | 257.3 | 154.2 |
| Dep. | Lat. | Dep. | Lat. | Dep.  | Lat. | Dep. | Lat.  | Dep. | Lat. | Dep.  | Lat.  | Dep. | Lat.  | Dep.  |

C c

for 5  $\frac{1}{2}$  Points.

TABLE II. Difference of Latitude and Departure for 3 Points.

| Dist | Lat  | Dep  | Dist | Lat  | Dep  | Dist | Lat   | Dep   | Dist | Lat   | Dep   | Dist | Lat   | Dep   |
|------|------|------|------|------|------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.8 | 00.6 | 61   | 50.7 | 33.9 | 121  | 100.6 | 67.2  | 181  | 150.5 | 100.5 | 241  | 200.4 | 133.5 |
| 2    | 01.7 | 01.1 | 62   | 51.5 | 34.4 | 22   | 101.4 | 67.8  | 82   | 151.3 | 101.1 | 42   | 201.2 | 134.0 |
| 3    | 02.5 | 01.7 | 63   | 52.4 | 35.0 | 23   | 102.3 | 68.3  | 83   | 152.1 | 101.7 | 43   | 202.0 | 135.0 |
| 4    | 03.3 | 02.2 | 64   | 53.2 | 35.6 | 24   | 103.1 | 68.9  | 84   | 153.0 | 102.2 | 44   | 202.8 | 135.5 |
| 5    | 04.2 | 02.8 | 65   | 54.0 | 36.1 | 25   | 103.9 | 69.4  | 85   | 153.8 | 102.8 | 45   | 203.7 | 136.0 |
| 6    | 05.0 | 03.3 | 66   | 54.9 | 36.7 | 26   | 104.8 | 70.0  | 86   | 154.6 | 103.3 | 46   | 204.5 | 136.5 |
| 7    | 05.8 | 03.9 | 67   | 55.7 | 37.2 | 27   | 105.6 | 70.5  | 87   | 155.5 | 103.9 | 47   | 205.3 | 137.0 |
| 8    | 06.7 | 04.4 | 68   | 56.5 | 37.8 | 28   | 106.4 | 71.1  | 88   | 156.3 | 104.4 | 48   | 206.2 | 137.5 |
| 9    | 07.5 | 05.0 | 69   | 57.4 | 38.3 | 29   | 107.2 | 71.7  | 89   | 157.1 | 105.0 | 49   | 207.0 | 138.0 |
| 10   | 08.3 | 05.6 | 70   | 58.2 | 38.9 | 30   | 108.1 | 72.2  | 90   | 158.0 | 105.5 | 50   | 207.8 | 138.5 |
| 11   | 09.1 | 06.1 | 71   | 59.0 | 39.4 | 31   | 108.9 | 72.8  | 191  | 158.8 | 106.1 | 251  | 208.7 | 139.0 |
| 12   | 10.0 | 06.7 | 72   | 59.9 | 40.0 | 32   | 109.7 | 73.3  | 92   | 159.6 | 106.7 | 52   | 209.5 | 140.0 |
| 13   | 10.8 | 07.2 | 73   | 60.7 | 40.6 | 33   | 110.6 | 73.9  | 93   | 160.4 | 107.2 | 53   | 210.3 | 140.5 |
| 14   | 11.6 | 07.8 | 74   | 61.5 | 41.1 | 34   | 111.4 | 74.4  | 94   | 161.3 | 107.8 | 54   | 211.2 | 141.0 |
| 15   | 12.5 | 08.3 | 75   | 62.4 | 41.7 | 35   | 112.2 | 75.0  | 95   | 162.1 | 108.3 | 55   | 212.0 | 141.5 |
| 16   | 13.3 | 08.9 | 76   | 63.2 | 42.2 | 36   | 113.1 | 75.5  | 96   | 162.9 | 108.9 | 56   | 212.8 | 142.0 |
| 17   | 14.1 | 09.4 | 77   | 64.0 | 42.8 | 37   | 113.9 | 76.1  | 97   | 163.8 | 109.4 | 57   | 213.7 | 142.5 |
| 18   | 15.0 | 10.0 | 78   | 64.8 | 43.3 | 38   | 114.7 | 76.7  | 98   | 164.6 | 110.0 | 58   | 214.5 | 143.0 |
| 19   | 15.8 | 10.6 | 79   | 65.7 | 43.9 | 39   | 115.6 | 77.2  | 99   | 165.4 | 110.5 | 59   | 215.3 | 143.5 |
| 20   | 16.6 | 11.1 | 80   | 66.5 | 44.4 | 40   | 116.4 | 77.8  | 200  | 166.3 | 111.1 | 60   | 216.1 | 144.0 |
| 21   | 17.5 | 11.7 | 81   | 67.3 | 45.0 | 41   | 117.2 | 78.3  | 201  | 167.1 | 111.7 | 261  | 217.0 | 145.0 |
| 22   | 18.3 | 12.2 | 82   | 68.2 | 45.6 | 42   | 118.1 | 78.9  | 02   | 167.9 | 112.2 | 62   | 217.8 | 145.5 |
| 23   | 19.1 | 12.8 | 83   | 69.0 | 46.1 | 43   | 118.9 | 79.4  | 03   | 168.8 | 112.8 | 63   | 218.6 | 146.0 |
| 24   | 20.0 | 13.3 | 84   | 69.8 | 46.7 | 44   | 119.7 | 80.0  | 04   | 169.6 | 113.3 | 64   | 219.5 | 146.5 |
| 25   | 20.8 | 13.9 | 85   | 70.7 | 47.2 | 45   | 120.5 | 80.5  | 05   | 170.4 | 113.9 | 65   | 220.3 | 147.0 |
| 26   | 21.6 | 14.4 | 86   | 71.5 | 47.8 | 46   | 121.4 | 81.1  | 06   | 171.3 | 114.4 | 66   | 221.1 | 147.5 |
| 27   | 22.4 | 15.0 | 87   | 72.3 | 48.3 | 47   | 122.2 | 81.7  | 07   | 172.1 | 115.0 | 67   | 222.0 | 148.0 |
| 28   | 23.3 | 15.6 | 88   | 73.2 | 48.9 | 48   | 123.0 | 82.2  | 08   | 172.9 | 115.5 | 68   | 222.8 | 148.5 |
| 29   | 24.1 | 16.1 | 89   | 74.0 | 49.4 | 49   | 123.9 | 82.8  | 09   | 173.8 | 116.1 | 69   | 223.6 | 149.0 |
| 30   | 24.9 | 16.7 | 90   | 74.8 | 50.0 | 50   | 124.7 | 83.3  | 10   | 174.6 | 116.7 | 70   | 224.5 | 149.5 |
| 31   | 25.8 | 17.2 | 91   | 75.7 | 50.6 | 51   | 125.5 | 83.9  | 211  | 175.4 | 117.2 | 271  | 225.3 | 150.0 |
| 32   | 26.6 | 17.8 | 92   | 76.5 | 51.1 | 52   | 126.4 | 84.4  | 12   | 176.2 | 117.8 | 72   | 226.1 | 150.5 |
| 33   | 27.4 | 18.3 | 93   | 77.3 | 51.7 | 53   | 127.2 | 85.0  | 13   | 177.1 | 118.3 | 73   | 227.0 | 151.0 |
| 34   | 28.3 | 18.9 | 94   | 78.1 | 52.2 | 54   | 128.0 | 85.5  | 14   | 177.9 | 118.9 | 74   | 227.8 | 151.5 |
| 35   | 29.1 | 19.4 | 95   | 79.0 | 52.8 | 55   | 128.9 | 86.1  | 15   | 178.7 | 119.4 | 75   | 228.6 | 152.0 |
| 36   | 29.9 | 20.0 | 96   | 79.8 | 53.3 | 56   | 129.7 | 86.7  | 16   | 179.6 | 120.0 | 76   | 229.4 | 152.5 |
| 37   | 30.8 | 20.6 | 97   | 80.6 | 53.9 | 57   | 130.5 | 87.2  | 17   | 180.4 | 120.5 | 77   | 230.3 | 153.0 |
| 38   | 31.6 | 21.1 | 98   | 81.5 | 54.4 | 58   | 131.4 | 87.8  | 18   | 181.2 | 121.1 | 78   | 231.1 | 153.5 |
| 39   | 32.4 | 21.7 | 99   | 82.3 | 55.0 | 59   | 132.2 | 88.3  | 19   | 182.1 | 121.7 | 79   | 231.9 | 154.0 |
| 40   | 33.3 | 22.2 | 100  | 83.1 | 55.6 | 60   | 133.0 | 88.9  | 20   | 182.9 | 122.2 | 80   | 232.8 | 154.5 |
| 41   | 34.1 | 22.8 | 101  | 84.0 | 56.1 | 61   | 133.8 | 89.4  | 221  | 183.7 | 122.8 | 281  | 233.6 | 155.0 |
| 42   | 34.9 | 23.3 | 102  | 84.8 | 56.7 | 62   | 134.7 | 90.0  | 22   | 184.6 | 123.3 | 82   | 234.4 | 155.5 |
| 43   | 35.8 | 23.9 | 03   | 85.6 | 57.2 | 63   | 135.5 | 90.5  | 23   | 185.4 | 123.9 | 83   | 235.3 | 156.0 |
| 44   | 36.6 | 24.4 | 04   | 86.5 | 57.8 | 64   | 136.3 | 91.1  | 24   | 186.2 | 124.4 | 84   | 236.1 | 156.5 |
| 45   | 37.4 | 25.0 | 05   | 87.3 | 58.3 | 65   | 137.2 | 91.7  | 25   | 187.1 | 125.0 | 85   | 236.9 | 157.0 |
| 46   | 38.2 | 25.6 | 06   | 88.1 | 58.9 | 66   | 138.0 | 92.2  | 26   | 187.9 | 125.5 | 86   | 237.8 | 157.5 |
| 47   | 39.1 | 26.1 | 07   | 89.0 | 59.4 | 67   | 138.8 | 92.8  | 27   | 188.7 | 126.1 | 87   | 238.6 | 158.0 |
| 48   | 39.9 | 26.7 | 08   | 89.8 | 60.0 | 68   | 139.7 | 93.3  | 28   | 189.5 | 126.7 | 88   | 239.4 | 158.5 |
| 49   | 40.7 | 27.2 | 09   | 90.6 | 60.5 | 69   | 140.5 | 93.9  | 29   | 190.4 | 127.2 | 89   | 240.3 | 159.0 |
| 50   | 41.6 | 27.8 | 10   | 91.4 | 61.1 | 70   | 141.3 | 94.4  | 30   | 191.2 | 127.8 | 90   | 241.1 | 159.5 |
| 51   | 42.4 | 28.3 | 111  | 92.3 | 61.7 | 171  | 142.2 | 95.0  | 231  | 192.0 | 128.3 | 291  | 241.9 | 160.0 |
| 52   | 43.2 | 28.9 | 12   | 93.1 | 62.2 | 72   | 143.0 | 95.5  | 32   | 192.9 | 128.9 | 92   | 242.8 | 160.5 |
| 53   | 44.1 | 29.4 | 13   | 93.9 | 62.8 | 73   | 143.8 | 96.1  | 33   | 193.7 | 129.4 | 93   | 243.6 | 161.0 |
| 54   | 44.9 | 30.0 | 14   | 94.9 | 63.3 | 74   | 144.7 | 96.7  | 34   | 194.5 | 130.0 | 94   | 244.4 | 161.5 |
| 55   | 45.7 | 30.6 | 15   | 95.6 | 63.9 | 75   | 145.5 | 97.2  | 35   | 195.4 | 130.5 | 95   | 245.2 | 162.0 |
| 56   | 46.6 | 31.1 | 16   | 96.4 | 64.4 | 76   | 146.3 | 97.8  | 36   | 196.2 | 131.1 | 96   | 246.1 | 162.5 |
| 57   | 47.4 | 31.7 | 17   | 97.3 | 65.0 | 77   | 147.1 | 98.3  | 37   | 197.0 | 131.7 | 97   | 246.9 | 163.0 |
| 58   | 48.2 | 32.2 | 18   | 98.1 | 65.5 | 78   | 148.0 | 98.9  | 38   | 197.9 | 132.2 | 98   | 247.7 | 163.5 |
| 59   | 49.1 | 32.8 | 19   | 98.9 | 66.1 | 79   | 148.8 | 99.4  | 39   | 198.7 | 132.8 | 99   | 248.5 | 164.0 |
| 60   | 49.9 | 33.3 | 20   | 99.8 | 66.7 | 180  | 149.6 | 100.0 | 240  | 199.5 | 133.3 | 300  | 249.4 | 164.5 |

for 5 Points.

TABLE II. Difference of Latitude and Departure for  $3\frac{1}{4}$  Points.

| Diff | Lat. | Dep. | Diff | Lat. | Dep. | Diff | Lat.  | Dep.  | Diff | Lat.  | Dep.  | Diff | Lat.  | Dep.  |
|------|------|------|------|------|------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.8 | 00.6 | 61   | 49.0 | 36.3 | 121  | 97.2  | 72.1  | 181  | 145.4 | 107.8 | 241  | 193.5 | 143.6 |
| 2    | 01.6 | 01.2 | 62   | 49.8 | 36.9 | 22   | 98.0  | 72.7  | 82   | 146.2 | 108.4 | 42   | 194.3 | 144.2 |
| 3    | 02.4 | 01.8 | 63   | 50.6 | 37.5 | 23   | 98.8  | 73.3  | 83   | 147.0 | 109.0 | 43   | 195.1 | 144.8 |
| 4    | 03.2 | 02.4 | 64   | 51.4 | 38.1 | 24   | 99.6  | 73.9  | 84   | 147.8 | 109.6 | 44   | 195.9 | 145.4 |
| 5    | 04.0 | 03.0 | 65   | 52.2 | 38.7 | 25   | 100.4 | 74.5  | 85   | 148.6 | 110.2 | 45   | 196.7 | 146.0 |
| 6    | 04.8 | 03.6 | 66   | 53.0 | 39.3 | 26   | 101.2 | 75.1  | 86   | 149.4 | 110.8 | 46   | 197.5 | 146.6 |
| 7    | 05.6 | 04.2 | 67   | 53.8 | 39.9 | 27   | 102.0 | 75.7  | 87   | 150.2 | 111.4 | 47   | 198.4 | 147.1 |
| 8    | 06.4 | 04.8 | 68   | 54.6 | 40.5 | 28   | 102.8 | 76.3  | 88   | 151.0 | 112.0 | 48   | 199.2 | 147.7 |
| 9    | 07.2 | 05.4 | 69   | 55.4 | 41.1 | 29   | 103.6 | 76.9  | 89   | 151.8 | 112.6 | 49   | 200.0 | 148.3 |
| 10   | 08.0 | 06.0 | 70   | 56.2 | 41.7 | 30   | 104.4 | 77.4  | 90   | 152.6 | 113.2 | 50   | 200.8 | 148.9 |
| 11   | 08.8 | 06.6 | 71   | 57.0 | 42.3 | 31   | 105.2 | 78.0  | 91   | 153.4 | 113.8 | 51   | 201.6 | 149.5 |
| 12   | 09.6 | 07.1 | 72   | 57.8 | 42.9 | 32   | 106.0 | 78.6  | 92   | 154.2 | 114.4 | 52   | 202.4 | 150.1 |
| 13   | 10.4 | 07.7 | 73   | 58.6 | 43.5 | 33   | 106.8 | 79.2  | 93   | 155.0 | 115.0 | 53   | 203.2 | 150.7 |
| 14   | 11.2 | 08.3 | 74   | 59.4 | 44.1 | 34   | 107.6 | 79.8  | 94   | 155.8 | 115.6 | 54   | 204.0 | 151.3 |
| 15   | 12.0 | 08.9 | 75   | 60.2 | 44.7 | 35   | 108.4 | 80.4  | 95   | 156.6 | 116.2 | 55   | 204.8 | 151.9 |
| 16   | 12.8 | 09.5 | 76   | 61.0 | 45.3 | 36   | 109.2 | 81.0  | 96   | 157.4 | 116.8 | 56   | 205.6 | 152.5 |
| 17   | 13.7 | 10.1 | 77   | 61.8 | 45.9 | 37   | 110.0 | 81.6  | 97   | 158.2 | 117.4 | 57   | 206.4 | 153.1 |
| 18   | 14.5 | 10.7 | 78   | 62.6 | 46.5 | 38   | 110.8 | 82.2  | 98   | 159.0 | 118.0 | 58   | 207.2 | 153.7 |
| 19   | 15.3 | 11.3 | 79   | 63.4 | 47.1 | 39   | 111.6 | 82.8  | 99   | 159.8 | 118.6 | 59   | 208.0 | 154.3 |
| 20   | 16.1 | 11.9 | 80   | 64.2 | 47.7 | 40   | 112.4 | 83.4  | 200  | 160.6 | 119.1 | 60   | 208.8 | 154.9 |
| 21   | 16.9 | 12.5 | 81   | 65.0 | 48.3 | 41   | 113.2 | 84.0  | 201  | 161.4 | 119.7 | 61   | 209.6 | 155.5 |
| 22   | 17.7 | 13.1 | 82   | 65.8 | 48.9 | 42   | 114.0 | 84.6  | 02   | 162.2 | 120.3 | 62   | 210.4 | 156.1 |
| 23   | 18.5 | 13.7 | 83   | 66.7 | 49.4 | 43   | 114.8 | 85.2  | 03   | 163.0 | 120.9 | 63   | 211.2 | 156.7 |
| 24   | 19.3 | 14.3 | 84   | 67.5 | 50.0 | 44   | 115.6 | 85.8  | 04   | 163.8 | 121.5 | 64   | 212.0 | 157.3 |
| 25   | 20.1 | 14.9 | 85   | 68.3 | 50.6 | 45   | 116.4 | 86.4  | 05   | 164.6 | 122.1 | 65   | 212.8 | 157.9 |
| 26   | 20.9 | 15.5 | 86   | 69.1 | 51.2 | 46   | 117.2 | 87.0  | 06   | 165.4 | 122.7 | 66   | 213.6 | 158.5 |
| 27   | 21.7 | 16.1 | 87   | 69.9 | 51.8 | 47   | 118.0 | 87.6  | 07   | 166.2 | 123.3 | 67   | 214.4 | 159.1 |
| 28   | 22.5 | 16.7 | 88   | 70.7 | 52.4 | 48   | 118.8 | 88.2  | 08   | 167.0 | 123.9 | 68   | 215.2 | 159.7 |
| 29   | 23.3 | 17.3 | 89   | 71.5 | 53.0 | 49   | 119.7 | 88.8  | 09   | 167.8 | 124.5 | 69   | 216.0 | 160.3 |
| 30   | 24.1 | 17.9 | 90   | 72.3 | 53.6 | 50   | 120.5 | 89.4  | 10   | 168.6 | 125.1 | 70   | 216.8 | 160.9 |
| 31   | 24.9 | 18.5 | 91   | 73.1 | 54.2 | 51   | 121.3 | 90.0  | 211  | 169.4 | 125.7 | 271  | 217.6 | 161.4 |
| 32   | 25.7 | 19.1 | 92   | 73.9 | 54.8 | 52   | 122.1 | 90.6  | 12   | 170.2 | 126.3 | 72   | 218.4 | 162.0 |
| 33   | 26.5 | 19.7 | 93   | 74.7 | 55.4 | 53   | 122.9 | 91.1  | 13   | 171.0 | 126.9 | 73   | 219.2 | 162.6 |
| 34   | 27.3 | 20.3 | 94   | 75.5 | 56.0 | 54   | 123.7 | 91.7  | 14   | 171.8 | 127.5 | 74   | 220.0 | 163.2 |
| 35   | 28.1 | 20.9 | 95   | 76.3 | 56.6 | 55   | 124.5 | 92.3  | 15   | 172.7 | 128.1 | 75   | 220.8 | 163.8 |
| 36   | 28.9 | 21.4 | 96   | 77.1 | 57.2 | 56   | 125.3 | 92.9  | 16   | 173.5 | 128.7 | 76   | 221.6 | 164.4 |
| 37   | 29.7 | 22.0 | 97   | 77.9 | 57.8 | 57   | 126.1 | 93.5  | 17   | 174.3 | 129.3 | 77   | 222.4 | 165.0 |
| 38   | 30.5 | 22.6 | 98   | 78.7 | 58.4 | 58   | 126.9 | 94.1  | 18   | 175.1 | 129.9 | 78   | 223.2 | 165.6 |
| 39   | 31.3 | 23.2 | 99   | 79.5 | 59.0 | 59   | 127.7 | 94.7  | 19   | 175.9 | 130.5 | 79   | 224.0 | 166.2 |
| 40   | 32.1 | 23.8 | 100  | 80.3 | 59.6 | 60   | 128.5 | 95.3  | 20   | 176.7 | 131.1 | 80   | 224.8 | 166.8 |
| 41   | 32.9 | 24.4 | 101  | 81.1 | 60.2 | 161  | 129.3 | 95.9  | 221  | 177.5 | 131.7 | 281  | 225.7 | 167.4 |
| 42   | 33.7 | 25.0 | 02   | 81.9 | 60.8 | 62   | 130.1 | 96.5  | 22   | 178.3 | 132.3 | 82   | 226.5 | 168.0 |
| 43   | 34.5 | 25.6 | 03   | 82.7 | 61.4 | 63   | 130.9 | 97.1  | 23   | 179.1 | 132.9 | 83   | 227.3 | 168.6 |
| 44   | 35.3 | 26.2 | 04   | 83.5 | 62.0 | 64   | 131.7 | 97.7  | 24   | 179.9 | 133.4 | 84   | 228.1 | 169.2 |
| 45   | 36.1 | 26.8 | 05   | 84.3 | 62.6 | 65   | 132.5 | 98.3  | 25   | 180.7 | 134.0 | 85   | 228.9 | 169.8 |
| 46   | 36.9 | 27.4 | 06   | 85.1 | 63.1 | 66   | 133.3 | 98.9  | 26   | 181.5 | 134.6 | 86   | 229.7 | 170.4 |
| 47   | 37.7 | 28.0 | 07   | 85.9 | 63.7 | 67   | 134.1 | 99.5  | 27   | 182.3 | 135.2 | 87   | 230.5 | 171.0 |
| 48   | 38.5 | 28.6 | 08   | 86.7 | 64.3 | 68   | 134.9 | 100.1 | 28   | 183.1 | 135.8 | 88   | 231.3 | 171.6 |
| 49   | 39.3 | 29.2 | 09   | 87.5 | 64.9 | 69   | 135.7 | 100.7 | 29   | 183.9 | 136.4 | 89   | 232.1 | 172.2 |
| 50   | 40.1 | 29.8 | 10   | 88.3 | 65.5 | 70   | 136.5 | 101.3 | 30   | 184.7 | 137.0 | 90   | 232.9 | 172.8 |
| 51   | 41.0 | 30.4 | 111  | 89.1 | 66.1 | 171  | 137.3 | 101.9 | 231  | 185.5 | 137.6 | 291  | 233.7 | 173.4 |
| 52   | 41.8 | 31.0 | 12   | 89.9 | 66.7 | 72   | 138.1 | 102.5 | 32   | 186.3 | 138.2 | 92   | 234.5 | 174.0 |
| 53   | 42.6 | 31.6 | 13   | 90.7 | 67.3 | 73   | 138.9 | 103.1 | 33   | 187.1 | 138.8 | 93   | 235.3 | 174.6 |
| 54   | 43.4 | 32.2 | 14   | 91.5 | 67.9 | 74   | 139.7 | 103.7 | 34   | 187.9 | 139.4 | 94   | 236.1 | 175.1 |
| 55   | 44.2 | 32.8 | 15   | 92.4 | 68.5 | 75   | 140.5 | 104.3 | 35   | 188.7 | 140.0 | 95   | 236.9 | 175.7 |
| 56   | 45.0 | 33.4 | 16   | 93.2 | 69.1 | 76   | 141.3 | 104.9 | 36   | 189.5 | 140.6 | 96   | 237.7 | 176.3 |
| 57   | 45.8 | 34.0 | 17   | 94.0 | 69.7 | 77   | 142.1 | 105.4 | 37   | 190.3 | 141.2 | 97   | 238.5 | 176.9 |
| 58   | 46.6 | 4.6  | 18   | 94.8 | 70.3 | 78   | 142.9 | 106.0 | 38   | 191.1 | 141.8 | 98   | 239.3 | 177.5 |
| 59   | 47.4 | 35.1 | 19   | 95.6 | 70.9 | 79   | 143.7 | 106.6 | 39   | 191.9 | 142.4 | 99   | 240.1 | 178.1 |
| 60   | 48.2 | 35.7 | 20   | 96.4 | 71.5 | 80   | 144.5 | 107.2 | 240  | 192.7 | 143.0 | 300  | 240.9 | 178.7 |
| Diff | Dep. | Lat. | Diff | Dep. | Lat. | Diff | Dep.  | Lat.  | Diff | Dep.  | Lat.  | Diff | Dep.  | Lat.  |



TABLE II. Difference of Latitude and Departure for  $3\frac{1}{2}$  Points.

| Dist | Lat. | Dep. | Dist | Lat. | Dep. | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  |
|------|------|------|------|------|------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.8 | 00.6 | 61   | 47.1 | 38.7 | 121  | 93.5  | 76.7  | 181  | 139.9 | 114.8 | 241  | 186.3 | 153.3 |
| 2    | 01.5 | 01.3 | 62   | 47.9 | 39.3 | 22   | 94.3  | 77.4  | 82   | 140.6 | 115.4 | 42   | 187.0 | 154.1 |
| 3    | 02.3 | 01.9 | 63   | 48.7 | 40.0 | 23   | 95.1  | 78.0  | 83   | 141.4 | 116.0 | 43   | 187.8 | 154.7 |
| 4    | 03.1 | 02.5 | 64   | 49.5 | 40.6 | 24   | 95.8  | 78.6  | 84   | 142.2 | 116.6 | 44   | 188.6 | 155.4 |
| 5    | 03.9 | 03.2 | 65   | 50.2 | 41.2 | 25   | 96.6  | 79.3  | 85   | 143.0 | 117.3 | 45   | 189.3 | 156.0 |
| 6    | 04.6 | 03.8 | 66   | 51.0 | 41.9 | 26   | 97.4  | 79.9  | 86   | 143.7 | 118.0 | 46   | 190.1 | 156.6 |
| 7    | 05.4 | 04.4 | 67   | 51.8 | 42.5 | 27   | 98.1  | 80.5  | 87   | 144.5 | 118.6 | 47   | 190.9 | 157.2 |
| 8    | 06.2 | 05.1 | 68   | 52.6 | 43.1 | 28   | 98.9  | 81.2  | 88   | 145.3 | 119.2 | 48   | 191.6 | 157.8 |
| 9    | 07.0 | 05.7 | 69   | 53.3 | 43.8 | 29   | 99.7  | 81.8  | 89   | 146.1 | 119.9 | 49   | 192.4 | 158.4 |
| 10   | 07.7 | 06.3 | 70   | 54.1 | 44.4 | 30   | 100.5 | 82.4  | 90   | 146.8 | 120.5 | 50   | 193.2 | 159.0 |
| 11   | 08.5 | 07.0 | 71   | 54.9 | 45.0 | 31   | 101.2 | 83.1  | 91   | 147.6 | 121.1 | 51   | 194.0 | 159.6 |
| 12   | 09.3 | 07.6 | 72   | 55.6 | 45.7 | 32   | 102.0 | 83.7  | 92   | 148.4 | 121.8 | 52   | 194.7 | 160.2 |
| 13   | 10.1 | 08.2 | 73   | 56.4 | 46.3 | 33   | 102.8 | 84.3  | 93   | 149.1 | 122.4 | 53   | 195.5 | 160.8 |
| 14   | 10.8 | 08.9 | 74   | 57.2 | 46.9 | 34   | 103.6 | 85.0  | 94   | 149.9 | 123.0 | 54   | 196.3 | 161.4 |
| 15   | 11.6 | 09.5 | 75   | 58.0 | 47.6 | 35   | 104.3 | 85.6  | 95   | 150.7 | 123.7 | 55   | 197.1 | 162.0 |
| 16   | 12.4 | 10.1 | 76   | 58.7 | 48.2 | 36   | 105.1 | 86.2  | 96   | 151.4 | 124.3 | 56   | 197.8 | 162.6 |
| 17   | 13.1 | 10.8 | 77   | 59.5 | 48.8 | 37   | 105.9 | 86.9  | 97   | 152.2 | 124.9 | 57   | 198.6 | 163.2 |
| 18   | 13.9 | 11.4 | 78   | 60.3 | 49.5 | 38   | 106.6 | 87.5  | 98   | 153.0 | 125.6 | 58   | 199.4 | 163.8 |
| 19   | 14.7 | 12.0 | 79   | 61.1 | 50.1 | 39   | 107.4 | 88.1  | 99   | 153.8 | 126.2 | 59   | 200.1 | 164.4 |
| 20   | 15.5 | 12.7 | 80   | 61.8 | 50.7 | 40   | 108.2 | 88.8  | 200  | 154.6 | 126.8 | 60   | 200.9 | 165.0 |
| 21   | 16.2 | 13.3 | 81   | 62.6 | 51.4 | 41   | 109.0 | 89.4  | 201  | 155.3 | 127.5 | 61   | 201.7 | 165.6 |
| 22   | 17.0 | 14.0 | 82   | 63.4 | 52.0 | 42   | 109.7 | 90.0  | 02   | 156.1 | 128.1 | 62   | 202.5 | 166.2 |
| 23   | 17.8 | 14.6 | 83   | 64.1 | 52.6 | 43   | 110.5 | 90.7  | 03   | 156.9 | 128.7 | 63   | 203.2 | 166.8 |
| 24   | 18.5 | 15.2 | 84   | 64.9 | 53.3 | 44   | 111.3 | 91.3  | 04   | 157.6 | 129.4 | 64   | 204.0 | 167.4 |
| 25   | 19.3 | 15.9 | 85   | 65.7 | 53.9 | 45   | 112.1 | 92.0  | 05   | 158.4 | 130.0 | 65   | 204.8 | 168.0 |
| 26   | 20.1 | 16.5 | 86   | 66.5 | 54.5 | 46   | 112.8 | 92.6  | 06   | 159.2 | 130.6 | 66   | 205.6 | 168.6 |
| 27   | 20.9 | 17.1 | 87   | 67.2 | 55.2 | 47   | 113.6 | 93.2  | 07   | 160.0 | 131.3 | 67   | 206.3 | 169.2 |
| 28   | 21.6 | 17.8 | 88   | 68.0 | 55.8 | 48   | 114.4 | 93.9  | 08   | 160.7 | 131.9 | 68   | 207.1 | 169.8 |
| 29   | 22.4 | 18.4 | 89   | 68.8 | 56.4 | 49   | 115.1 | 94.5  | 09   | 161.5 | 132.5 | 69   | 207.9 | 170.4 |
| 30   | 23.2 | 19.0 | 90   | 69.6 | 57.1 | 50   | 115.9 | 95.1  | 10   | 162.3 | 133.2 | 70   | 208.6 | 171.0 |
| 31   | 24.0 | 19.7 | 91   | 70.3 | 57.7 | 51   | 116.7 | 95.8  | 211  | 163.1 | 133.8 | 71   | 209.4 | 171.6 |
| 32   | 24.7 | 20.3 | 92   | 71.1 | 58.3 | 52   | 117.5 | 96.4  | 12   | 163.8 | 134.4 | 72   | 210.2 | 172.2 |
| 33   | 25.5 | 20.9 | 93   | 71.9 | 59.0 | 53   | 118.2 | 97.0  | 13   | 164.6 | 135.1 | 73   | 211.0 | 172.8 |
| 34   | 26.3 | 21.6 | 94   | 72.6 | 59.6 | 54   | 119.0 | 97.7  | 14   | 165.4 | 135.7 | 74   | 211.7 | 173.4 |
| 35   | 27.1 | 22.2 | 95   | 73.4 | 60.2 | 55   | 119.8 | 98.3  | 15   | 166.1 | 136.3 | 75   | 212.5 | 174.0 |
| 36   | 27.8 | 22.8 | 96   | 74.2 | 60.9 | 56   | 120.6 | 98.9  | 16   | 166.9 | 137.0 | 76   | 213.3 | 174.6 |
| 37   | 28.6 | 23.5 | 97   | 75.0 | 61.5 | 57   | 121.3 | 99.6  | 17   | 167.7 | 137.6 | 77   | 214.1 | 175.2 |
| 38   | 29.4 | 24.1 | 98   | 75.7 | 62.1 | 58   | 122.1 | 100.2 | 18   | 168.5 | 138.2 | 78   | 214.8 | 175.8 |
| 39   | 30.1 | 24.7 | 99   | 76.5 | 62.8 | 59   | 122.9 | 100.8 | 19   | 169.2 | 138.9 | 79   | 215.6 | 176.4 |
| 40   | 30.9 | 25.4 | 100  | 77.2 | 63.4 | 60   | 123.6 | 101.5 | 20   | 170.0 | 139.5 | 80   | 216.4 | 177.0 |
| 41   | 31.7 | 26.0 | 101  | 78.0 | 64.0 | 161  | 124.4 | 102.1 | 221  | 170.8 | 140.1 | 281  | 217.1 | 177.6 |
| 42   | 32.5 | 26.6 | 02   | 78.8 | 64.7 | 62   | 125.2 | 102.7 | 22   | 171.6 | 140.8 | 82   | 217.9 | 178.2 |
| 43   | 33.2 | 27.3 | 03   | 79.6 | 65.3 | 63   | 126.0 | 103.4 | 23   | 172.3 | 141.4 | 83   | 218.7 | 178.8 |
| 44   | 34.0 | 27.9 | 04   | 80.4 | 66.0 | 64   | 126.7 | 104.0 | 24   | 173.1 | 142.0 | 84   | 219.5 | 179.4 |
| 45   | 34.8 | 28.5 | 05   | 81.1 | 66.6 | 65   | 127.5 | 104.6 | 25   | 173.9 | 142.7 | 85   | 220.3 | 180.0 |
| 46   | 35.6 | 29.2 | 06   | 81.9 | 67.2 | 66   | 128.3 | 105.3 | 26   | 174.6 | 143.3 | 86   | 221.1 | 180.6 |
| 47   | 36.3 | 29.8 | 07   | 82.7 | 67.9 | 67   | 129.1 | 105.9 | 27   | 175.4 | 144.0 | 87   | 221.8 | 181.2 |
| 48   | 37.1 | 30.4 | 08   | 83.5 | 68.5 | 68   | 129.8 | 106.5 | 28   | 176.2 | 144.6 | 88   | 222.6 | 181.8 |
| 49   | 37.9 | 31.1 | 09   | 84.2 | 69.1 | 69   | 130.6 | 107.2 | 29   | 177.0 | 145.2 | 89   | 223.3 | 182.4 |
| 50   | 38.6 | 31.7 | 10   | 85.0 | 69.8 | 70   | 131.4 | 107.8 | 30   | 177.7 | 145.9 | 90   | 224.1 | 183.0 |
| 51   | 39.4 | 32.3 | 111  | 85.8 | 70.4 | 171  | 132.1 | 108.4 | 231  | 178.5 | 146.5 | 291  | 224.9 | 183.6 |
| 52   | 40.2 | 33.0 | 12   | 86.6 | 71.0 | 72   | 132.9 | 109.1 | 32   | 179.3 | 147.2 | 92   | 225.6 | 184.2 |
| 53   | 41.0 | 33.6 | 13   | 87.3 | 71.7 | 73   | 133.7 | 109.7 | 33   | 180.1 | 147.8 | 93   | 226.4 | 184.8 |
| 54   | 41.7 | 34.2 | 14   | 88.1 | 72.3 | 74   | 134.5 | 110.3 | 34   | 180.8 | 148.4 | 94   | 227.2 | 185.4 |
| 55   | 42.5 | 34.9 | 15   | 88.9 | 72.9 | 75   | 135.2 | 111.0 | 35   | 181.6 | 149.0 | 95   | 228.0 | 186.0 |
| 56   | 43.3 | 35.5 | 16   | 89.6 | 73.6 | 76   | 136.0 | 111.6 | 36   | 182.4 | 149.7 | 96   | 228.7 | 186.6 |
| 57   | 44.1 | 36.1 | 17   | 90.4 | 74.2 | 77   | 136.8 | 112.2 | 37   | 183.1 | 150.3 | 97   | 229.5 | 187.2 |
| 58   | 44.8 | 36.8 | 18   | 91.2 | 74.8 | 78   | 137.6 | 112.9 | 38   | 183.9 | 150.9 | 98   | 230.3 | 187.8 |
| 59   | 45.6 | 37.4 | 19   | 92.0 | 75.5 | 79   | 138.3 | 113.5 | 39   | 184.7 | 151.6 | 99   | 231.1 | 188.4 |
| 60   | 46.4 | 38.0 | 120  | 92.7 | 76.1 | 180  | 139.1 | 114.1 | 240  | 185.5 | 152.2 | 300  | 231.8 | 189.0 |

for  $4\frac{1}{2}$  Points.

TABLE II. Difference of Latitude and Departure for 3 $\frac{1}{2}$  Points.

| Dist | Lat  | Dep  | Dist | Lat  | Dep  | Dist | Lat   | Dep   | Dist | Lat   | Dep   | Dist | Lat   | Dep   |
|------|------|------|------|------|------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.7 | 00.7 | 61   | 45.2 | 41.0 | 121  | 89.6  | 81.2  | 181  | 134.1 | 121.5 | 241  | 178.5 | 161.8 |
| 2    | 01.5 | 01.3 | 62   | 45.9 | 41.6 | 22   | 90.4  | 81.9  | 82   | 134.8 | 122.2 | 42   | 179.3 | 162.5 |
| 3    | 02.2 | 02.0 | 63   | 46.7 | 42.3 | 23   | 91.1  | 82.6  | 83   | 135.6 | 122.9 | 43   | 180.0 | 163.2 |
| 4    | 03.0 | 02.7 | 64   | 47.4 | 43.0 | 24   | 91.9  | 83.3  | 84   | 136.3 | 123.5 | 44   | 180.7 | 163.8 |
| 5    | 03.7 | 03.4 | 65   | 48.2 | 43.6 | 25   | 92.6  | 83.9  | 85   | 137.0 | 124.2 | 45   | 181.5 | 164.5 |
| 6    | 04.4 | 04.0 | 66   | 48.9 | 44.3 | 26   | 93.3  | 84.6  | 86   | 137.8 | 124.9 | 46   | 182.2 | 165.2 |
| 7    | 05.2 | 04.7 | 67   | 49.6 | 45.0 | 27   | 94.1  | 85.3  | 87   | 138.5 | 125.6 | 47   | 183.0 | 165.8 |
| 8    | 05.9 | 05.4 | 68   | 50.4 | 45.7 | 28   | 94.8  | 85.9  | 88   | 139.3 | 126.2 | 48   | 183.7 | 166.5 |
| 9    | 06.7 | 06.0 | 69   | 51.1 | 46.3 | 29   | 95.6  | 86.6  | 89   | 140.0 | 126.9 | 49   | 184.4 | 167.2 |
| 10   | 07.4 | 06.7 | 70   | 51.9 | 47.0 | 30   | 96.3  | 87.3  | 90   | 140.7 | 127.6 | 50   | 185.2 | 167.9 |
| 11   | 08.2 | 07.4 | 71   | 52.6 | 47.7 | 31   | 97.0  | 88.0  | 191  | 141.5 | 128.2 | 251  | 185.9 | 168.5 |
| 12   | 08.9 | 08.1 | 72   | 53.3 | 48.3 | 32   | 97.8  | 88.6  | 92   | 142.2 | 128.9 | 52   | 186.7 | 169.2 |
| 13   | 09.6 | 08.7 | 73   | 54.1 | 49.0 | 33   | 98.5  | 89.3  | 93   | 143.0 | 129.6 | 53   | 187.4 | 169.9 |
| 14   | 10.4 | 09.4 | 74   | 54.8 | 49.7 | 34   | 99.3  | 90.0  | 94   | 143.7 | 130.3 | 54   | 188.2 | 170.5 |
| 15   | 11.1 | 10.1 | 75   | 55.6 | 50.4 | 35   | 100.0 | 90.6  | 95   | 144.4 | 130.9 | 55   | 188.9 | 171.2 |
| 16   | 11.9 | 10.7 | 76   | 56.3 | 51.0 | 36   | 100.7 | 91.3  | 96   | 145.2 | 131.6 | 56   | 189.6 | 171.9 |
| 17   | 12.6 | 11.4 | 77   | 57.0 | 51.7 | 37   | 101.5 | 92.0  | 97   | 145.9 | 132.3 | 57   | 190.4 | 172.6 |
| 18   | 13.3 | 12.1 | 78   | 57.8 | 52.4 | 38   | 102.2 | 92.7  | 98   | 146.7 | 132.9 | 58   | 191.1 | 173.2 |
| 19   | 14.1 | 12.8 | 79   | 58.5 | 53.0 | 39   | 103.0 | 93.3  | 99   | 147.4 | 133.6 | 59   | 191.9 | 173.9 |
| 20   | 14.8 | 13.4 | 80   | 59.3 | 53.7 | 40   | 103.7 | 94.0  | 200  | 148.2 | 134.3 | 60   | 192.6 | 174.6 |
| 21   | 15.6 | 14.1 | 81   | 60.0 | 54.4 | 41   | 104.4 | 94.7  | 201  | 148.9 | 135.0 | 61   | 193.3 | 175.2 |
| 22   | 16.3 | 14.8 | 82   | 60.7 | 55.1 | 42   | 105.2 | 95.3  | 02   | 149.6 | 135.6 | 62   | 194.1 | 175.9 |
| 23   | 17.0 | 15.4 | 83   | 61.5 | 55.8 | 43   | 105.9 | 96.0  | 03   | 150.4 | 136.3 | 63   | 194.8 | 176.6 |
| 24   | 17.8 | 16.1 | 84   | 62.2 | 56.4 | 44   | 106.7 | 96.7  | 04   | 151.1 | 137.0 | 64   | 195.6 | 177.3 |
| 25   | 18.5 | 16.8 | 85   | 63.0 | 57.1 | 45   | 107.4 | 97.4  | 05   | 151.9 | 137.6 | 65   | 196.3 | 177.9 |
| 26   | 19.3 | 17.5 | 86   | 63.7 | 57.7 | 46   | 108.2 | 98.0  | 06   | 152.6 | 138.3 | 66   | 197.0 | 178.6 |
| 27   | 20.0 | 18.1 | 87   | 64.4 | 58.4 | 47   | 108.9 | 98.7  | 07   | 153.3 | 139.0 | 67   | 197.8 | 179.3 |
| 28   | 20.7 | 18.8 | 88   | 65.2 | 59.1 | 48   | 109.6 | 99.4  | 08   | 154.1 | 139.7 | 68   | 198.5 | 179.9 |
| 29   | 21.5 | 19.5 | 89   | 65.9 | 59.8 | 49   | 110.4 | 100.0 | 09   | 154.8 | 140.3 | 69   | 199.3 | 180.6 |
| 30   | 22.2 | 20.1 | 90   | 66.7 | 60.4 | 50   | 111.1 | 100.7 | 10   | 155.6 | 141.0 | 70   | 200.0 | 181.3 |
| 31   | 23.0 | 20.8 | 91   | 67.4 | 61.1 | 51   | 111.9 | 101.4 | 211  | 156.3 | 141.7 | 271  | 200.7 | 182.0 |
| 32   | 23.7 | 21.5 | 92   | 68.2 | 61.8 | 52   | 112.6 | 102.1 | 12   | 157.0 | 142.3 | 72   | 201.5 | 182.6 |
| 33   | 24.4 | 22.2 | 93   | 68.9 | 62.4 | 53   | 113.3 | 102.7 | 13   | 157.8 | 143.0 | 73   | 202.2 | 183.3 |
| 34   | 25.2 | 22.8 | 94   | 69.6 | 63.1 | 54   | 114.1 | 103.4 | 14   | 158.5 | 143.7 | 74   | 203.0 | 184.0 |
| 35   | 25.9 | 23.5 | 95   | 70.4 | 63.8 | 55   | 114.8 | 104.1 | 15   | 159.3 | 144.4 | 75   | 203.7 | 184.6 |
| 36   | 26.7 | 24.2 | 96   | 71.1 | 64.5 | 56   | 115.6 | 104.7 | 16   | 160.0 | 145.0 | 76   | 204.4 | 185.3 |
| 37   | 27.4 | 24.8 | 97   | 71.9 | 65.1 | 57   | 116.3 | 105.4 | 17   | 160.7 | 145.7 | 77   | 205.2 | 186.0 |
| 38   | 28.2 | 25.5 | 98   | 72.6 | 65.8 | 58   | 117.0 | 106.1 | 18   | 161.5 | 146.4 | 78   | 205.9 | 186.7 |
| 39   | 28.9 | 26.2 | 99   | 73.3 | 66.5 | 59   | 117.8 | 106.8 | 19   | 162.2 | 147.0 | 79   | 206.7 | 187.3 |
| 40   | 29.6 | 26.9 | 100  | 74.1 | 67.1 | 60   | 118.5 | 107.4 | 20   | 163.0 | 147.7 | 80   | 207.4 | 188.0 |
| 41   | 30.4 | 27.5 | 101  | 74.8 | 67.8 | 161  | 119.3 | 108.1 | 221  | 163.7 | 148.4 | 281  | 208.2 | 188.7 |
| 42   | 31.1 | 28.2 | 02   | 75.6 | 68.5 | 62   | 120.0 | 108.8 | 22   | 164.4 | 149.1 | 82   | 208.9 | 189.3 |
| 43   | 31.9 | 28.9 | 03   | 76.3 | 69.2 | 63   | 120.7 | 109.4 | 23   | 165.2 | 149.7 | 83   | 209.6 | 190.0 |
| 44   | 32.6 | 29.5 | 04   | 77.0 | 69.8 | 64   | 121.5 | 110.1 | 24   | 165.9 | 150.4 | 84   | 210.4 | 190.7 |
| 45   | 33.3 | 30.2 | 05   | 77.8 | 70.5 | 65   | 122.2 | 110.8 | 25   | 166.7 | 151.1 | 85   | 211.1 | 191.4 |
| 46   | 34.1 | 30.9 | 06   | 78.5 | 71.2 | 66   | 123.0 | 111.5 | 26   | 167.4 | 151.7 | 86   | 211.9 | 192.0 |
| 47   | 34.8 | 31.6 | 07   | 79.3 | 71.8 | 67   | 123.7 | 112.1 | 27   | 168.2 | 152.4 | 87   | 212.6 | 192.7 |
| 48   | 35.6 | 32.2 | 08   | 80.0 | 72.5 | 68   | 124.4 | 112.8 | 28   | 168.9 | 153.1 | 88   | 213.3 | 193.4 |
| 49   | 36.3 | 32.9 | 09   | 80.7 | 73.2 | 69   | 125.2 | 113.5 | 29   | 169.6 | 153.8 | 89   | 214.1 | 194.0 |
| 50   | 37.0 | 33.6 | 10   | 81.5 | 73.9 | 70   | 125.9 | 114.1 | 30   | 170.4 | 154.5 | 90   | 214.8 | 194.7 |
| 51   | 37.8 | 34.2 | 111  | 82.2 | 74.5 | 171  | 126.7 | 114.8 | 231  | 171.1 | 155.1 | 291  | 215.6 | 195.4 |
| 52   | 38.5 | 34.9 | 12   | 83.0 | 75.2 | 72   | 127.4 | 115.5 | 32   | 171.9 | 155.8 | 92   | 216.3 | 196.1 |
| 53   | 39.3 | 35.6 | 13   | 83.7 | 75.9 | 73   | 128.2 | 116.2 | 33   | 172.6 | 156.4 | 93   | 217.0 | 196.7 |
| 54   | 40.0 | 36.3 | 14   | 84.4 | 76.5 | 74   | 128.9 | 116.8 | 35   | 173.3 | 157.1 | 94   | 217.8 | 197.4 |
| 55   | 40.7 | 36.9 | 15   | 85.2 | 77.2 | 75   | 129.6 | 117.5 | 35   | 174.1 | 157.8 | 95   | 218.5 | 198.1 |
| 56   | 41.5 | 37.6 | 16   | 85.9 | 77.9 | 76   | 130.4 | 118.2 | 36   | 174.8 | 158.5 | 96   | 219.3 | 198.7 |
| 57   | 42.2 | 38.3 | 17   | 86.7 | 78.6 | 77   | 131.1 | 118.8 | 37   | 175.6 | 159.1 | 97   | 220.0 | 199.9 |
| 58   | 43.0 | 38.9 | 18   | 87.5 | 79.2 | 78   | 131.9 | 119.5 | 38   | 176.3 | 159.8 | 98   | 220.7 | 200.1 |
| 59   | 43.7 | 39.6 | 19   | 88.2 | 79.9 | 79   | 132.6 | 120.2 | 39   | 177.0 | 160.5 | 99   | 221.5 | 200.8 |
| 60   | 44.5 | 40.3 | 120  | 88.9 | 80.6 | 180  | 133.3 | 120.9 | 240  | 177.8 | 161.1 | 300  | 222.2 | 201.4 |

for 4 $\frac{1}{4}$  Points.

TABLE II. Difference of Latitude and Departure for 4 Points.

| Diff | Lat  | Dep  | Diff | Lat  | Dep  | Diff | Lat   | Dep   | Diff | Lat   | Dep   | Diff | Lat   | Dep   |
|------|------|------|------|------|------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.7 | 00.7 | 61   | 43.1 | 43.1 | 121  | 85.6  | 85.6  | 181  | 128.0 | 128.0 | 241  | 170.4 | 170.4 |
| 2    | 01.4 | 01.4 | 62   | 43.8 | 43.8 | 22   | 86.3  | 86.3  | 82   | 128.7 | 128.7 | 42   | 171.1 | 171.1 |
| 3    | 02.1 | 02.1 | 63   | 44.5 | 44.5 | 23   | 87.0  | 87.0  | 83   | 129.4 | 129.4 | 43   | 171.8 | 171.8 |
| 4    | 02.8 | 02.8 | 64   | 45.3 | 45.3 | 24   | 87.7  | 87.7  | 84   | 130.1 | 130.1 | 44   | 172.5 | 172.5 |
| 5    | 03.5 | 03.5 | 65   | 46.0 | 46.0 | 25   | 88.4  | 88.4  | 85   | 130.8 | 130.8 | 45   | 173.2 | 173.2 |
| 6    | 04.2 | 04.2 | 66   | 46.7 | 46.7 | 26   | 89.1  | 89.1  | 86   | 131.5 | 131.5 | 46   | 173.9 | 173.9 |
| 7    | 04.9 | 04.9 | 67   | 47.4 | 47.4 | 27   | 89.8  | 89.8  | 87   | 132.2 | 132.2 | 47   | 174.6 | 174.6 |
| 8    | 05.7 | 05.7 | 68   | 48.1 | 48.1 | 28   | 90.5  | 90.5  | 88   | 132.9 | 132.9 | 48   | 175.4 | 175.4 |
| 9    | 06.4 | 06.4 | 69   | 48.8 | 48.8 | 29   | 91.2  | 91.2  | 89   | 133.6 | 133.6 | 49   | 176.1 | 176.1 |
| 10   | 07.1 | 07.1 | 70   | 49.5 | 49.5 | 30   | 91.9  | 91.9  | 90   | 134.3 | 134.3 | 50   | 176.8 | 176.8 |
| 11   | 07.8 | 07.8 | 71   | 50.2 | 50.2 | 131  | 92.6  | 92.6  | 91   | 135.1 | 135.1 | 251  | 177.5 | 177.5 |
| 12   | 08.5 | 08.5 | 72   | 50.9 | 50.9 | 32   | 93.3  | 93.3  | 92   | 135.8 | 135.8 | 52   | 178.2 | 178.2 |
| 13   | 09.2 | 09.2 | 73   | 51.6 | 51.6 | 33   | 94.0  | 94.0  | 93   | 136.5 | 136.5 | 53   | 178.9 | 178.9 |
| 14   | 09.9 | 09.9 | 74   | 52.3 | 52.3 | 34   | 94.7  | 94.7  | 94   | 137.2 | 137.2 | 54   | 179.6 | 179.6 |
| 15   | 10.6 | 10.6 | 75   | 53.0 | 53.0 | 35   | 95.5  | 95.5  | 95   | 137.9 | 137.9 | 55   | 180.3 | 180.3 |
| 16   | 11.3 | 11.3 | 76   | 53.7 | 53.7 | 36   | 96.2  | 96.2  | 96   | 138.6 | 138.6 | 56   | 181.0 | 181.0 |
| 17   | 12.0 | 12.0 | 77   | 54.4 | 54.4 | 37   | 96.9  | 96.9  | 97   | 139.3 | 139.3 | 57   | 181.7 | 181.7 |
| 18   | 12.7 | 12.7 | 78   | 55.2 | 55.2 | 38   | 97.6  | 97.6  | 98   | 140.0 | 140.0 | 58   | 182.4 | 182.4 |
| 19   | 13.4 | 13.4 | 79   | 55.9 | 55.9 | 39   | 98.3  | 98.3  | 99   | 140.7 | 140.7 | 59   | 183.1 | 183.1 |
| 20   | 14.1 | 14.1 | 80   | 56.6 | 56.6 | 40   | 99.0  | 99.0  | 200  | 141.4 | 141.4 | 60   | 183.8 | 183.8 |
| 21   | 14.8 | 14.8 | 81   | 57.3 | 57.3 | 141  | 99.7  | 99.7  | 201  | 142.1 | 142.1 | 261  | 184.5 | 184.5 |
| 22   | 15.6 | 15.6 | 82   | 58.0 | 58.0 | 42   | 100.4 | 100.4 | 02   | 142.8 | 142.8 | 62   | 185.3 | 185.3 |
| 23   | 16.3 | 16.3 | 83   | 58.7 | 58.7 | 43   | 101.1 | 101.1 | 03   | 143.5 | 143.5 | 63   | 186.0 | 186.0 |
| 24   | 17.0 | 17.0 | 84   | 59.4 | 59.4 | 44   | 101.8 | 101.8 | 04   | 144.2 | 144.2 | 64   | 186.7 | 186.7 |
| 25   | 17.7 | 17.7 | 85   | 60.1 | 60.1 | 45   | 102.5 | 102.5 | 05   | 144.9 | 144.9 | 65   | 187.4 | 187.4 |
| 26   | 18.4 | 18.4 | 86   | 60.8 | 60.8 | 46   | 103.2 | 103.2 | 06   | 145.7 | 145.7 | 66   | 188.1 | 188.1 |
| 27   | 19.1 | 19.1 | 87   | 61.5 | 61.5 | 47   | 103.9 | 103.9 | 07   | 146.4 | 146.4 | 67   | 188.8 | 188.8 |
| 28   | 19.8 | 19.8 | 88   | 62.2 | 62.2 | 48   | 104.6 | 104.6 | 08   | 147.1 | 147.1 | 68   | 189.5 | 189.5 |
| 29   | 20.5 | 20.5 | 89   | 62.9 | 62.9 | 49   | 105.4 | 105.4 | 09   | 147.8 | 147.8 | 69   | 190.2 | 190.2 |
| 30   | 21.2 | 21.2 | 90   | 63.6 | 63.6 | 50   | 106.1 | 106.1 | 10   | 148.5 | 148.5 | 70   | 190.9 | 190.9 |
| 31   | 21.9 | 21.9 | 91   | 64.3 | 64.3 | 151  | 106.8 | 106.8 | 211  | 149.2 | 149.2 | 271  | 191.6 | 191.6 |
| 32   | 22.6 | 22.6 | 92   | 65.1 | 65.1 | 52   | 107.5 | 107.5 | 12   | 149.9 | 149.9 | 72   | 192.3 | 192.3 |
| 33   | 23.3 | 23.3 | 93   | 65.8 | 65.8 | 53   | 108.2 | 108.2 | 13   | 150.6 | 150.6 | 73   | 193.0 | 193.0 |
| 34   | 24.0 | 24.0 | 94   | 66.5 | 66.5 | 54   | 108.9 | 108.9 | 14   | 151.3 | 151.3 | 74   | 193.7 | 193.7 |
| 35   | 24.7 | 24.7 | 95   | 67.2 | 67.2 | 55   | 109.6 | 109.6 | 15   | 152.0 | 152.0 | 75   | 194.4 | 194.4 |
| 36   | 25.5 | 25.5 | 96   | 67.9 | 67.9 | 56   | 110.3 | 110.3 | 16   | 152.7 | 152.7 | 76   | 195.1 | 195.1 |
| 37   | 26.2 | 26.2 | 97   | 68.6 | 68.6 | 57   | 111.0 | 111.0 | 17   | 153.4 | 153.4 | 77   | 195.9 | 195.9 |
| 38   | 26.9 | 26.9 | 98   | 69.3 | 69.3 | 58   | 111.7 | 111.7 | 18   | 154.1 | 154.1 | 78   | 196.6 | 196.6 |
| 39   | 27.6 | 27.6 | 99   | 70.0 | 70.0 | 59   | 112.4 | 112.4 | 19   | 154.8 | 154.8 | 79   | 197.3 | 197.3 |
| 40   | 28.3 | 28.3 | 100  | 70.7 | 70.7 | 60   | 113.1 | 113.1 | 20   | 155.6 | 155.6 | 80   | 198.0 | 198.0 |
| 41   | 29.0 | 29.0 | 101  | 71.4 | 71.4 | 161  | 113.8 | 113.8 | 221  | 156.3 | 156.3 | 281  | 198.7 | 198.7 |
| 42   | 29.7 | 29.7 | 02   | 72.1 | 72.1 | 62   | 114.5 | 114.5 | 22   | 157.0 | 157.0 | 82   | 199.4 | 199.4 |
| 43   | 30.4 | 30.4 | 03   | 72.8 | 72.8 | 63   | 115.3 | 115.3 | 23   | 157.7 | 157.7 | 83   | 200.1 | 200.1 |
| 44   | 31.1 | 31.1 | 04   | 73.5 | 73.5 | 64   | 116.0 | 116.0 | 24   | 158.4 | 158.4 | 84   | 200.8 | 200.8 |
| 45   | 31.8 | 31.8 | 05   | 74.2 | 74.2 | 65   | 116.7 | 116.7 | 25   | 159.1 | 159.1 | 85   | 201.5 | 201.5 |
| 46   | 32.5 | 32.5 | 06   | 74.9 | 74.9 | 66   | 117.4 | 117.4 | 26   | 159.8 | 159.8 | 86   | 202.2 | 202.2 |
| 47   | 33.2 | 33.2 | 07   | 75.7 | 75.7 | 67   | 118.1 | 118.1 | 27   | 160.5 | 160.5 | 87   | 202.9 | 202.9 |
| 48   | 33.9 | 33.9 | 08   | 76.4 | 76.4 | 68   | 118.8 | 118.8 | 28   | 161.2 | 161.2 | 88   | 203.6 | 203.6 |
| 49   | 34.6 | 34.6 | 09   | 77.1 | 77.1 | 69   | 119.5 | 119.5 | 29   | 161.9 | 161.9 | 89   | 204.3 | 204.3 |
| 50   | 35.4 | 35.4 | 10   | 77.8 | 77.8 | 70   | 120.2 | 120.2 | 30   | 162.6 | 162.6 | 90   | 205.0 | 205.0 |
| 51   | 36.1 | 36.1 | 111  | 78.5 | 78.5 | 171  | 120.9 | 120.9 | 231  | 163.3 | 163.3 | 291  | 205.8 | 205.8 |
| 52   | 36.8 | 36.8 | 12   | 79.2 | 79.2 | 72   | 121.6 | 121.6 | 32   | 164.0 | 164.0 | 92   | 206.5 | 206.5 |
| 53   | 37.5 | 37.5 | 13   | 79.9 | 79.9 | 73   | 122.3 | 122.3 | 33   | 164.7 | 164.7 | 93   | 207.2 | 207.2 |
| 54   | 38.2 | 38.2 | 14   | 80.6 | 80.6 | 74   | 123.0 | 123.0 | 34   | 165.5 | 165.5 | 94   | 207.9 | 207.9 |
| 55   | 38.9 | 38.9 | 15   | 81.3 | 81.3 | 75   | 123.7 | 123.7 | 35   | 166.2 | 166.2 | 95   | 208.6 | 208.6 |
| 56   | 39.6 | 39.6 | 16   | 82.0 | 82.0 | 76   | 124.4 | 124.4 | 36   | 166.9 | 166.9 | 96   | 209.3 | 209.3 |
| 57   | 40.3 | 40.3 | 17   | 82.7 | 82.7 | 77   | 125.2 | 125.2 | 37   | 167.6 | 167.6 | 97   | 210.0 | 210.0 |
| 58   | 41.0 | 41.0 | 18   | 83.4 | 83.4 | 78   | 125.9 | 125.9 | 38   | 168.3 | 168.3 | 98   | 210.7 | 210.7 |
| 59   | 41.7 | 41.7 | 19   | 84.1 | 84.1 | 79   | 126.6 | 126.6 | 39   | 169.0 | 169.0 | 99   | 211.4 | 211.4 |
| 60   | 42.4 | 42.4 | 20   | 84.8 | 84.8 | 180  | 127.3 | 127.3 | 240  | 169.7 | 169.7 | 300  | 212.1 | 212.1 |

Diff Dep Lat Diff Dep Lat Diff Dep Lat Diff Dep Lat Diff Dep Lat

for 4 Points.



TABLE III. Difference of Latitude and Departure for 1 Degree.

| Diff | Lat. | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.0 | 61   | 61.0  | 01.1 | 121  | 121.0 | 02.1 | 181  | 181.0 | 03.1 | 241  | 241.0 | 04.1 |
| 2    | 02.0 | 00.0 | 62   | 62.0  | 01.1 | 22   | 122.0 | 02.1 | 82   | 182.0 | 04.1 | 42   | 242.0 | 04.2 |
| 3    | 03.0 | 00.1 | 63   | 63.0  | 01.1 | 23   | 123.0 | 02.1 | 83   | 183.0 | 03.2 | 43   | 243.0 | 04.2 |
| 4    | 04.0 | 00.1 | 64   | 64.0  | 01.1 | 24   | 124.0 | 02.2 | 84   | 184.0 | 03.2 | 44   | 244.0 | 04.2 |
| 5    | 05.0 | 00.1 | 65   | 65.0  | 01.1 | 25   | 125.0 | 02.2 | 85   | 185.0 | 03.2 | 45   | 255.0 | 04.2 |
| 6    | 06.0 | 00.1 | 66   | 66.0  | 01.2 | 26   | 126.0 | 02.2 | 86   | 186.0 | 03.2 | 46   | 246.0 | 04.2 |
| 7    | 07.0 | 00.1 | 67   | 67.0  | 01.2 | 27   | 127.0 | 02.2 | 87   | 187.0 | 03.2 | 47   | 247.0 | 04.2 |
| 8    | 08.0 | 00.1 | 68   | 68.0  | 01.2 | 28   | 128.0 | 02.2 | 88   | 188.0 | 03.2 | 48   | 248.0 | 04.3 |
| 9    | 09.0 | 00.2 | 69   | 69.0  | 01.2 | 29   | 129.0 | 02.2 | 89   | 189.0 | 03.3 | 49   | 249.0 | 04.3 |
| 10   | 10.0 | 00.2 | 70   | 70.0  | 01.2 | 30   | 130.0 | 02.3 | 90   | 190.0 | 03.3 | 50   | 250.0 | 04.3 |
| 11   | 11.0 | 00.2 | 71   | 71.0  | 01.2 | 131  | 131.0 | 02.3 | 191  | 191.0 | 03.3 | 251  | 251.0 | 04.3 |
| 12   | 12.0 | 00.2 | 72   | 72.0  | 01.3 | 32   | 132.0 | 02.3 | 92   | 192.0 | 03.3 | 52   | 252.0 | 04.3 |
| 13   | 13.0 | 00.2 | 73   | 73.0  | 01.3 | 33   | 133.0 | 02.3 | 93   | 193.0 | 03.3 | 53   | 253.0 | 04.3 |
| 14   | 14.0 | 00.2 | 74   | 74.0  | 01.3 | 34   | 134.0 | 02.3 | 94   | 194.0 | 03.3 | 54   | 254.0 | 04.4 |
| 15   | 15.0 | 00.3 | 75   | 75.0  | 01.3 | 35   | 135.0 | 02.3 | 95   | 195.0 | 03.4 | 55   | 255.0 | 04.4 |
| 16   | 16.0 | 00.3 | 76   | 76.0  | 01.3 | 36   | 136.0 | 02.4 | 96   | 196.0 | 03.4 | 56   | 256.0 | 04.4 |
| 17   | 17.0 | 00.3 | 77   | 77.0  | 01.3 | 37   | 137.0 | 02.4 | 97   | 197.0 | 03.4 | 57   | 257.0 | 04.4 |
| 18   | 18.0 | 00.3 | 78   | 78.0  | 01.4 | 38   | 138.0 | 02.4 | 98   | 198.0 | 03.4 | 58   | 258.0 | 04.4 |
| 19   | 19.0 | 00.3 | 79   | 79.0  | 01.4 | 39   | 139.0 | 02.4 | 99   | 199.0 | 03.4 | 59   | 259.0 | 04.4 |
| 20   | 20.0 | 00.4 | 80   | 80.0  | 01.4 | 40   | 140.0 | 02.4 | 200  | 200.0 | 03.4 | 60   | 260.0 | 04.5 |
| 21   | 21.0 | 00.4 | 81   | 81.0  | 01.4 | 141  | 141.0 | 02.4 | 201  | 201.0 | 03.5 | 261  | 261.0 | 04.5 |
| 22   | 22.0 | 00.4 | 82   | 82.0  | 01.4 | 42   | 142.0 | 02.5 | 02   | 202.0 | 03.5 | 62   | 262.0 | 04.5 |
| 23   | 23.0 | 00.4 | 83   | 83.0  | 01.5 | 43   | 143.0 | 02.5 | 03   | 203.0 | 03.5 | 63   | 263.0 | 04.5 |
| 24   | 24.0 | 00.4 | 84   | 84.0  | 01.5 | 44   | 144.0 | 02.5 | 04   | 204.0 | 03.5 | 64   | 264.0 | 04.5 |
| 25   | 25.0 | 00.4 | 85   | 85.0  | 01.5 | 45   | 145.0 | 02.5 | 05   | 205.0 | 03.5 | 65   | 265.0 | 04.6 |
| 26   | 26.0 | 00.5 | 86   | 86.0  | 01.5 | 46   | 146.0 | 02.5 | 06   | 206.0 | 03.5 | 66   | 266.0 | 04.6 |
| 27   | 27.0 | 00.5 | 87   | 87.0  | 01.5 | 47   | 147.0 | 02.5 | 07   | 207.0 | 03.6 | 67   | 267.0 | 04.6 |
| 28   | 28.0 | 00.5 | 88   | 88.0  | 01.5 | 48   | 148.0 | 02.6 | 08   | 208.0 | 03.6 | 68   | 268.0 | 04.6 |
| 29   | 29.0 | 00.5 | 89   | 89.0  | 01.6 | 49   | 149.0 | 02.6 | 09   | 209.0 | 03.6 | 69   | 269.0 | 04.6 |
| 30   | 30.0 | 00.5 | 90   | 90.0  | 01.6 | 50   | 150.0 | 02.6 | 10   | 210.0 | 03.6 | 70   | 270.0 | 04.6 |
| 31   | 31.0 | 00.5 | 91   | 91.0  | 01.6 | 151  | 151.0 | 02.6 | 211  | 211.0 | 03.6 | 271  | 271.0 | 04.7 |
| 32   | 32.0 | 00.6 | 92   | 92.0  | 01.6 | 52   | 152.0 | 02.6 | 12   | 212.0 | 03.6 | 72   | 272.0 | 04.7 |
| 33   | 33.0 | 00.6 | 93   | 93.0  | 01.6 | 53   | 153.0 | 02.6 | 13   | 213.0 | 03.7 | 73   | 273.0 | 04.7 |
| 34   | 34.0 | 00.6 | 94   | 94.0  | 01.6 | 54   | 154.0 | 02.7 | 14   | 214.0 | 03.7 | 74   | 274.0 | 04.7 |
| 35   | 35.0 | 00.6 | 95   | 95.0  | 01.7 | 55   | 155.0 | 02.7 | 15   | 215.0 | 03.7 | 75   | 275.0 | 04.7 |
| 36   | 36.0 | 00.6 | 96   | 96.0  | 01.7 | 56   | 156.0 | 02.7 | 16   | 216.0 | 03.7 | 76   | 276.0 | 04.7 |
| 37   | 37.0 | 00.6 | 97   | 97.0  | 01.7 | 57   | 157.0 | 02.7 | 17   | 217.0 | 03.7 | 77   | 277.0 | 04.8 |
| 38   | 38.0 | 00.7 | 98   | 98.0  | 01.7 | 58   | 158.0 | 02.7 | 18   | 218.0 | 03.8 | 78   | 278.0 | 04.8 |
| 39   | 39.0 | 00.7 | 99   | 99.0  | 01.7 | 59   | 159.0 | 02.7 | 19   | 219.0 | 03.8 | 79   | 279.0 | 04.8 |
| 40   | 40.0 | 00.7 | 100  | 100.0 | 01.7 | 60   | 160.0 | 02.8 | 20   | 220.0 | 03.8 | 80   | 280.0 | 04.8 |
| 41   | 41.0 | 00.7 | 101  | 101.0 | 01.8 | 161  | 161.0 | 02.8 | 221  | 221.0 | 03.8 | 281  | 281.0 | 04.8 |
| 42   | 42.0 | 00.7 | 02   | 102.0 | 01.8 | 62   | 162.0 | 02.8 | 22   | 222.0 | 03.8 | 82   | 282.0 | 04.8 |
| 43   | 43.0 | 00.8 | 03   | 103.0 | 01.8 | 63   | 163.0 | 02.8 | 23   | 223.0 | 03.8 | 83   | 283.0 | 04.9 |
| 44   | 44.0 | 00.8 | 04   | 104.0 | 01.8 | 64   | 164.0 | 02.8 | 24   | 224.0 | 03.9 | 84   | 284.0 | 04.9 |
| 45   | 45.0 | 00.8 | 05   | 105.0 | 01.8 | 65   | 165.0 | 02.9 | 25   | 225.0 | 03.9 | 85   | 285.0 | 04.9 |
| 46   | 46.0 | 00.8 | 06   | 106.0 | 01.8 | 66   | 166.0 | 02.9 | 26   | 226.0 | 03.9 | 86   | 286.0 | 04.9 |
| 47   | 47.0 | 00.8 | 07   | 107.0 | 01.9 | 67   | 167.0 | 02.9 | 27   | 227.0 | 03.9 | 87   | 287.0 | 04.9 |
| 48   | 48.0 | 00.8 | 08   | 108.0 | 01.9 | 68   | 168.0 | 02.9 | 28   | 228.0 | 03.9 | 88   | 288.0 | 04.9 |
| 49   | 49.0 | 00.9 | 09   | 109.0 | 01.9 | 69   | 169.0 | 02.9 | 29   | 229.0 | 03.9 | 89   | 289.0 | 05.0 |
| 50   | 50.0 | 00.9 | 10   | 110.0 | 01.9 | 70   | 170.0 | 02.9 | 30   | 230.0 | 04.0 | 90   | 290.0 | 05.0 |
| 51   | 51.0 | 00.9 | 111  | 111.0 | 01.9 | 171  | 171.0 | 03.0 | 231  | 231.0 | 04.0 | 291  | 291.0 | 05.0 |
| 52   | 52.0 | 00.9 | 12   | 112.0 | 01.9 | 72   | 172.0 | 03.0 | 32   | 232.0 | 04.0 | 92   | 292.0 | 05.0 |
| 53   | 53.0 | 00.9 | 13   | 113.0 | 02.0 | 73   | 173.0 | 03.0 | 33   | 233.0 | 04.0 | 93   | 293.0 | 05.0 |
| 54   | 54.0 | 00.9 | 14   | 114.0 | 02.0 | 74   | 174.0 | 03.0 | 34   | 234.0 | 04.0 | 94   | 294.0 | 05.0 |
| 55   | 55.0 | 01.0 | 15   | 115.0 | 02.0 | 75   | 175.0 | 03.0 | 35   | 235.0 | 04.0 | 95   | 295.0 | 05.1 |
| 56   | 56.0 | 01.0 | 16   | 116.0 | 02.0 | 76   | 176.0 | 03.0 | 36   | 236.0 | 04.1 | 96   | 296.0 | 05.1 |
| 57   | 57.0 | 01.0 | 17   | 117.0 | 02.0 | 77   | 177.0 | 03.1 | 37   | 237.0 | 04.1 | 97   | 297.0 | 05.1 |
| 58   | 58.0 | 01.0 | 18   | 118.0 | 02.1 | 78   | 178.0 | 03.1 | 38   | 238.0 | 04.1 | 98   | 298.0 | 05.1 |
| 59   | 59.0 | 01.0 | 19   | 119.0 | 02.1 | 79   | 179.0 | 03.1 | 39   | 239.0 | 04.1 | 99   | 299.0 | 05.1 |
| 60   | 60.0 | 01.1 | 120  | 120.0 | 02.1 | 180  | 180.0 | 03.1 | 240  | 240.0 | 04.1 | 300  | 300.0 | 05.1 |
| Diff | Dep  | Lat. | Diff | Dep.  | Lat. | Diff | Dep.  | Lat. | Diff | Dep.  | Lat. | Diff | Dep.  | Lat. |

for 89 Degrees.

TABLE III. Difference of Latitude and Departure for 2 Degrees.

| Diff | Lat.    | Dep  | Diff | Lat.     | Dep  | Diff | Lat.     | Dep  | Diff | Lat.     | Dep  | Diff | Lat.     | Dep  | Diff | Lat.     | Dep  |
|------|---------|------|------|----------|------|------|----------|------|------|----------|------|------|----------|------|------|----------|------|
| 1    | 01.00.0 |      | 61   | 61.00.1  |      | 121  | 120.90.4 |      | 181  | 180.90.6 |      | 241  | 240.90.8 |      | 301  | 300.90.8 |      |
| 2    | 02.00.1 |      | 62   | 62.00.2  |      | 22   | 121.90.4 |      | 82   | 181.90.6 |      | 42   | 241.90.8 |      | 102  | 301.90.8 |      |
| 3    | 03.00.1 |      | 63   | 63.00.2  |      | 23   | 122.90.4 |      | 83   | 182.90.6 |      | 43   | 242.90.8 |      | 103  | 302.90.8 |      |
| 4    | 04.00.1 |      | 64   | 64.00.2  |      | 24   | 123.90.4 |      | 84   | 183.90.6 |      | 44   | 243.90.8 |      | 104  | 303.90.8 |      |
| 5    | 05.00.2 |      | 65   | 65.00.2  |      | 25   | 124.90.4 |      | 85   | 184.90.6 |      | 45   | 244.90.8 |      | 105  | 304.90.8 |      |
| 6    | 06.00.2 |      | 66   | 66.00.2  |      | 26   | 125.90.4 |      | 86   | 185.90.6 |      | 46   | 245.90.8 |      | 106  | 305.90.8 |      |
| 7    | 07.00.2 |      | 67   | 67.00.2  |      | 27   | 126.90.4 |      | 87   | 186.90.6 |      | 47   | 246.90.8 |      | 107  | 306.90.8 |      |
| 8    | 08.00.3 |      | 68   | 68.00.2  |      | 28   | 127.90.4 |      | 88   | 187.90.6 |      | 48   | 247.90.8 |      | 108  | 307.90.8 |      |
| 9    | 09.00.3 |      | 69   | 69.00.2  |      | 29   | 128.90.4 |      | 89   | 188.90.6 |      | 49   | 248.90.8 |      | 109  | 308.90.8 |      |
| 10   | 10.00.3 |      | 70   | 70.00.2  |      | 30   | 129.90.4 |      | 90   | 189.90.6 |      | 50   | 249.90.8 |      | 110  | 309.90.8 |      |
| 11   | 11.00.4 |      | 71   | 71.00.2  |      | 31   | 130.90.4 |      | 91   | 190.90.6 |      | 51   | 250.90.8 |      | 111  | 310.90.8 |      |
| 12   | 12.00.4 |      | 72   | 72.00.2  |      | 32   | 131.90.4 |      | 92   | 191.90.6 |      | 52   | 251.90.8 |      | 112  | 311.90.8 |      |
| 13   | 13.00.5 |      | 73   | 73.00.2  |      | 33   | 132.90.4 |      | 93   | 192.90.6 |      | 53   | 252.90.8 |      | 113  | 312.90.8 |      |
| 14   | 14.00.5 |      | 74   | 74.00.2  |      | 34   | 133.90.4 |      | 94   | 193.90.6 |      | 54   | 253.90.8 |      | 114  | 313.90.8 |      |
| 15   | 15.00.5 |      | 75   | 75.00.2  |      | 35   | 134.90.4 |      | 95   | 194.90.6 |      | 55   | 254.90.8 |      | 115  | 314.90.8 |      |
| 16   | 16.00.6 |      | 76   | 76.00.2  |      | 36   | 135.90.4 |      | 96   | 195.90.6 |      | 56   | 255.90.8 |      | 116  | 315.90.8 |      |
| 17   | 17.00.6 |      | 77   | 77.00.2  |      | 37   | 136.90.4 |      | 97   | 196.90.6 |      | 57   | 256.90.8 |      | 117  | 316.90.8 |      |
| 18   | 18.00.6 |      | 78   | 78.00.2  |      | 38   | 137.90.4 |      | 98   | 197.90.6 |      | 58   | 257.90.8 |      | 118  | 317.90.8 |      |
| 19   | 19.00.7 |      | 79   | 79.00.2  |      | 39   | 138.90.4 |      | 99   | 198.90.6 |      | 59   | 258.90.8 |      | 119  | 318.90.8 |      |
| 20   | 20.00.7 |      | 80   | 80.00.2  |      | 40   | 139.90.4 |      | 200  | 199.90.6 |      | 60   | 259.90.8 |      | 120  | 319.90.8 |      |
| 21   | 21.00.7 |      | 81   | 81.00.2  |      | 41   | 140.90.4 |      | 201  | 200.90.6 |      | 61   | 260.90.8 |      | 121  | 320.90.8 |      |
| 22   | 22.00.8 |      | 82   | 81.90.2  |      | 42   | 141.90.5 |      | 02   | 201.90.7 |      | 62   | 261.90.8 |      | 122  | 321.90.8 |      |
| 23   | 23.00.8 |      | 83   | 82.90.2  |      | 43   | 142.90.5 |      | 03   | 202.90.7 |      | 63   | 262.90.8 |      | 123  | 322.90.8 |      |
| 24   | 24.00.8 |      | 84   | 83.90.2  |      | 44   | 143.90.5 |      | 04   | 203.90.7 |      | 64   | 263.90.8 |      | 124  | 323.90.8 |      |
| 25   | 25.00.9 |      | 85   | 84.90.3  |      | 45   | 144.90.5 |      | 05   | 204.90.7 |      | 65   | 264.90.8 |      | 125  | 324.90.8 |      |
| 26   | 26.00.9 |      | 86   | 85.90.3  |      | 46   | 145.90.5 |      | 06   | 205.90.7 |      | 66   | 265.90.8 |      | 126  | 325.90.8 |      |
| 27   | 27.00.9 |      | 87   | 86.90.3  |      | 47   | 146.90.5 |      | 07   | 206.90.7 |      | 67   | 266.90.8 |      | 127  | 326.90.8 |      |
| 28   | 28.01.0 |      | 88   | 87.90.3  |      | 48   | 147.90.5 |      | 08   | 207.90.7 |      | 68   | 267.90.8 |      | 128  | 327.90.8 |      |
| 29   | 29.01.0 |      | 89   | 88.90.3  |      | 49   | 148.90.5 |      | 09   | 208.90.7 |      | 69   | 268.90.8 |      | 129  | 328.90.8 |      |
| 30   | 30.01.1 |      | 90   | 89.90.3  |      | 50   | 149.90.5 |      | 10   | 209.90.7 |      | 70   | 269.90.8 |      | 130  | 329.90.8 |      |
| 31   | 31.01.1 |      | 91   | 90.90.3  |      | 51   | 150.90.5 |      | 211  | 210.90.7 |      | 71   | 270.90.8 |      | 131  | 330.90.8 |      |
| 32   | 32.01.1 |      | 92   | 91.90.3  |      | 52   | 151.90.5 |      | 12   | 211.90.7 |      | 72   | 271.90.8 |      | 132  | 331.90.8 |      |
| 33   | 33.01.2 |      | 93   | 92.90.3  |      | 53   | 152.90.5 |      | 13   | 212.90.7 |      | 73   | 272.90.8 |      | 133  | 332.90.8 |      |
| 34   | 34.01.2 |      | 94   | 93.90.3  |      | 54   | 153.90.5 |      | 14   | 213.90.7 |      | 74   | 273.90.8 |      | 134  | 333.90.8 |      |
| 35   | 35.01.2 |      | 95   | 94.90.3  |      | 55   | 154.90.5 |      | 15   | 214.90.7 |      | 75   | 274.90.8 |      | 135  | 334.90.8 |      |
| 36   | 36.01.3 |      | 96   | 95.90.3  |      | 56   | 155.90.5 |      | 16   | 215.90.7 |      | 76   | 275.90.8 |      | 136  | 335.90.8 |      |
| 37   | 37.01.3 |      | 97   | 96.90.3  |      | 57   | 156.90.5 |      | 17   | 216.90.7 |      | 77   | 276.90.8 |      | 137  | 336.90.8 |      |
| 38   | 38.01.3 |      | 98   | 97.90.3  |      | 58   | 157.90.5 |      | 18   | 217.90.7 |      | 78   | 277.90.8 |      | 138  | 337.90.8 |      |
| 39   | 39.01.4 |      | 99   | 98.90.3  |      | 59   | 158.90.5 |      | 19   | 218.90.7 |      | 79   | 278.90.8 |      | 139  | 338.90.8 |      |
| 40   | 40.01.4 |      | 100  | 99.90.3  |      | 60   | 159.90.5 |      | 20   | 219.90.7 |      | 80   | 279.90.8 |      | 140  | 339.90.8 |      |
| 41   | 41.01.4 |      | 101  | 100.90.3 |      | 161  | 160.90.5 |      | 221  | 220.90.7 |      | 281  | 280.90.8 |      | 141  | 340.90.8 |      |
| 42   | 42.01.5 |      | 02   | 101.90.3 |      | 62   | 161.90.5 |      | 22   | 221.90.7 |      | 82   | 281.90.8 |      | 142  | 341.90.8 |      |
| 43   | 43.01.5 |      | 03   | 102.90.3 |      | 63   | 162.90.5 |      | 23   | 222.90.7 |      | 83   | 282.90.8 |      | 143  | 342.90.8 |      |
| 44   | 44.01.5 |      | 04   | 103.90.3 |      | 64   | 163.90.5 |      | 24   | 223.90.7 |      | 84   | 283.90.8 |      | 144  | 343.90.8 |      |
| 45   | 45.01.6 |      | 05   | 104.90.3 |      | 65   | 164.90.5 |      | 25   | 224.90.7 |      | 85   | 284.90.8 |      | 145  | 344.90.8 |      |
| 46   | 46.01.6 |      | 06   | 105.90.3 |      | 66   | 165.90.5 |      | 26   | 225.90.7 |      | 86   | 285.90.8 |      | 146  | 345.90.8 |      |
| 47   | 47.01.6 |      | 07   | 106.90.3 |      | 67   | 166.90.5 |      | 27   | 226.90.7 |      | 87   | 286.90.8 |      | 147  | 346.90.8 |      |
| 48   | 48.01.7 |      | 08   | 107.90.3 |      | 68   | 167.90.5 |      | 28   | 227.90.7 |      | 88   | 287.90.8 |      | 148  | 347.90.8 |      |
| 49   | 49.01.7 |      | 09   | 108.90.3 |      | 69   | 168.90.5 |      | 29   | 228.90.7 |      | 89   | 288.90.8 |      | 149  | 348.90.8 |      |
| 50   | 50.01.7 |      | 10   | 109.90.3 |      | 70   | 169.90.5 |      | 30   | 229.90.7 |      | 90   | 289.90.8 |      | 150  | 349.90.8 |      |
| 51   | 51.01.8 |      | 111  | 110.90.3 |      | 171  | 170.90.6 |      | 231  | 230.90.8 |      | 291  | 290.90.8 |      | 151  | 350.90.8 |      |
| 52   | 52.01.8 |      | 12   | 111.90.3 |      | 72   | 171.90.6 |      | 32   | 231.90.8 |      | 92   | 291.90.8 |      | 152  | 351.90.8 |      |
| 53   | 53.01.8 |      | 13   | 112.90.4 |      | 73   | 172.90.6 |      | 33   | 232.90.8 |      | 93   | 292.90.8 |      | 153  | 352.90.8 |      |
| 54   | 54.01.9 |      | 14   | 113.90.4 |      | 74   | 173.90.6 |      | 34   | 233.90.8 |      | 94   | 293.90.8 |      | 154  | 353.90.8 |      |
| 55   | 55.01.9 |      | 15   | 114.90.4 |      | 75   | 174.90.6 |      | 35   | 234.90.8 |      | 95   | 294.90.8 |      | 155  | 354.90.8 |      |
| 56   | 56.02.0 |      | 16   | 115.90.4 |      | 76   | 175.90.6 |      | 36   | 235.90.8 |      | 96   | 295.90.8 |      | 156  | 355.90.8 |      |
| 57   | 57.02.0 |      | 17   | 116.90.4 |      | 77   | 176.90.6 |      | 37   | 236.90.8 |      | 97   | 296.90.8 |      | 157  | 356.90.8 |      |
| 58   | 58.02.0 |      | 18   | 117.90.4 |      | 78   | 177.90.6 |      | 38   | 237.90.8 |      | 98   | 297.90.8 |      | 158  | 357.90.8 |      |
| 59   | 59.02.1 |      | 19   | 118.90.4 |      | 79   | 178.90.6 |      | 39   | 238.90.8 |      | 99   | 298.90.8 |      | 159  | 358.90.8 |      |
| 60   | 60.02.1 |      | 120  | 119.90.4 |      | 180  | 179.90.6 |      | 40   | 239.90.8 |      | 300  | 299.90.8 |      | 160  | 359.90.8 |      |
| Diff | Dep     | Lat. | Diff | Dep.     | Lat. | Diff | Dep.     | Lat. | Diff | Dep.     | Lat. | Diff | Dep.     | Lat. | Diff | Dep.     | Lat. |

for 88 Degrees.

TABLE III. Difference of Latitude and Departure for 3 Degrees.

| Diff | Lat. | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.1 | 61   | 60.9  | 03.2 | 121  | 120.8 | 06.3 | 181  | 180.7 | 09.5 | 241  | 240.7 | 12.6 |
| 2    | 02.0 | 00.1 | 62   | 61.9  | 03.2 | 22   | 121.8 | 06.4 | 82   | 181.7 | 09.5 | 42   | 241.7 | 12.7 |
| 3    | 03.0 | 00.2 | 63   | 62.9  | 03.3 | 23   | 122.8 | 06.4 | 83   | 182.7 | 09.6 | 43   | 242.7 | 12.7 |
| 4    | 04.0 | 00.2 | 64   | 63.9  | 03.3 | 24   | 123.8 | 06.5 | 84   | 183.7 | 09.6 | 44   | 243.7 | 12.8 |
| 5    | 05.0 | 00.3 | 65   | 64.9  | 03.4 | 25   | 124.8 | 06.5 | 85   | 184.7 | 09.7 | 45   | 244.7 | 12.8 |
| 6    | 06.0 | 00.3 | 66   | 65.9  | 03.5 | 26   | 125.8 | 06.6 | 86   | 185.7 | 09.7 | 46   | 245.7 | 12.9 |
| 7    | 07.0 | 00.4 | 67   | 66.9  | 03.5 | 27   | 126.8 | 06.6 | 87   | 186.7 | 09.8 | 47   | 246.7 | 12.9 |
| 8    | 08.0 | 00.4 | 68   | 67.9  | 03.6 | 28   | 127.8 | 06.7 | 88   | 187.7 | 09.8 | 48   | 247.7 | 13.0 |
| 9    | 09.0 | 00.5 | 69   | 68.9  | 03.6 | 29   | 128.8 | 06.8 | 89   | 188.7 | 09.9 | 49   | 248.7 | 13.0 |
| 10   | 10.0 | 00.5 | 70   | 69.9  | 03.7 | 30   | 129.8 | 06.8 | 90   | 189.7 | 09.9 | 50   | 249.7 | 13.1 |
| 11   | 11.0 | 00.6 | 71   | 70.9  | 03.7 | 131  | 130.8 | 06.9 | 191  | 190.7 | 10.0 | 251  | 250.6 | 13.1 |
| 12   | 12.0 | 00.6 | 72   | 71.9  | 03.8 | 32   | 131.8 | 06.9 | 92   | 191.7 | 10.0 | 52   | 251.6 | 13.2 |
| 13   | 13.0 | 00.7 | 73   | 72.9  | 03.8 | 33   | 132.8 | 07.0 | 93   | 192.7 | 10.1 | 53   | 252.6 | 13.2 |
| 14   | 14.0 | 00.7 | 74   | 73.9  | 03.9 | 34   | 133.8 | 07.0 | 94   | 193.7 | 10.1 | 54   | 253.6 | 13.3 |
| 15   | 15.0 | 00.8 | 75   | 74.9  | 03.9 | 35   | 134.8 | 07.1 | 95   | 194.7 | 10.2 | 55   | 254.6 | 13.3 |
| 16   | 16.0 | 00.8 | 76   | 75.9  | 04.0 | 36   | 135.8 | 07.1 | 96   | 195.7 | 10.3 | 56   | 255.6 | 13.4 |
| 17   | 17.0 | 00.9 | 77   | 76.9  | 04.0 | 37   | 136.8 | 07.2 | 97   | 196.7 | 10.3 | 57   | 256.6 | 13.4 |
| 18   | 18.0 | 00.9 | 78   | 77.9  | 04.1 | 38   | 137.8 | 07.2 | 98   | 197.7 | 10.4 | 58   | 257.6 | 13.5 |
| 19   | 19.0 | 01.0 | 79   | 78.9  | 04.1 | 39   | 138.8 | 07.3 | 99   | 198.7 | 10.4 | 59   | 258.6 | 13.6 |
| 20   | 20.0 | 01.0 | 80   | 79.9  | 04.2 | 40   | 139.8 | 07.3 | 200  | 199.7 | 10.5 | 60   | 259.6 | 13.6 |
| 21   | 21.0 | 01.1 | 81   | 80.9  | 04.2 | 141  | 140.8 | 07.4 | 201  | 200.7 | 10.5 | 61   | 260.6 | 13.7 |
| 22   | 22.0 | 01.1 | 82   | 81.9  | 04.3 | 42   | 141.8 | 07.4 | 02   | 201.7 | 10.6 | 62   | 261.6 | 13.7 |
| 23   | 23.0 | 01.2 | 83   | 82.9  | 04.3 | 43   | 142.8 | 07.5 | 03   | 202.7 | 10.6 | 63   | 262.6 | 13.8 |
| 24   | 24.0 | 01.3 | 84   | 83.9  | 04.4 | 44   | 143.8 | 07.5 | 04   | 203.7 | 10.7 | 64   | 263.6 | 13.8 |
| 25   | 25.0 | 01.3 | 85   | 84.9  | 04.4 | 45   | 144.8 | 07.6 | 05   | 204.7 | 10.7 | 65   | 264.6 | 13.9 |
| 26   | 26.0 | 01.4 | 86   | 85.9  | 04.5 | 46   | 145.8 | 07.6 | 06   | 205.7 | 10.8 | 66   | 265.6 | 13.9 |
| 27   | 27.0 | 01.4 | 87   | 86.9  | 04.6 | 47   | 146.8 | 07.7 | 07   | 206.7 | 10.8 | 67   | 266.6 | 14.0 |
| 28   | 28.0 | 01.5 | 88   | 87.9  | 04.6 | 48   | 147.8 | 07.7 | 08   | 207.7 | 10.9 | 68   | 267.6 | 14.0 |
| 29   | 29.0 | 01.5 | 89   | 88.9  | 04.7 | 49   | 148.8 | 07.8 | 09   | 208.7 | 10.9 | 69   | 268.6 | 14.1 |
| 30   | 30.0 | 01.6 | 90   | 89.9  | 04.7 | 50   | 149.8 | 07.9 | 10   | 209.7 | 11.0 | 70   | 269.6 | 14.1 |
| 31   | 31.0 | 01.6 | 91   | 90.9  | 04.8 | 151  | 150.8 | 07.9 | 211  | 210.7 | 11.0 | 271  | 270.6 | 14.2 |
| 32   | 32.0 | 01.7 | 92   | 91.9  | 04.8 | 52   | 151.8 | 08.0 | 12   | 211.7 | 11.1 | 72   | 271.6 | 14.2 |
| 33   | 33.0 | 01.7 | 93   | 92.9  | 04.9 | 53   | 152.8 | 08.0 | 13   | 212.7 | 11.1 | 73   | 272.6 | 14.3 |
| 34   | 34.0 | 01.8 | 94   | 93.9  | 04.9 | 54   | 153.8 | 08.1 | 14   | 213.7 | 11.2 | 74   | 273.6 | 14.3 |
| 35   | 35.0 | 01.8 | 95   | 94.9  | 05.0 | 55   | 154.8 | 08.1 | 15   | 214.7 | 11.2 | 75   | 274.6 | 14.4 |
| 36   | 36.0 | 01.9 | 96   | 95.9  | 05.0 | 56   | 155.8 | 08.2 | 16   | 215.7 | 11.3 | 76   | 275.6 | 14.4 |
| 37   | 37.0 | 01.9 | 97   | 96.9  | 05.1 | 57   | 156.8 | 08.2 | 17   | 216.7 | 11.4 | 77   | 276.6 | 14.5 |
| 38   | 38.0 | 02.0 | 98   | 97.9  | 05.1 | 58   | 157.8 | 08.3 | 18   | 217.7 | 11.4 | 78   | 277.6 | 14.5 |
| 39   | 39.0 | 02.0 | 99   | 98.9  | 05.2 | 59   | 158.8 | 08.3 | 19   | 218.7 | 11.5 | 79   | 278.6 | 14.6 |
| 40   | 39.9 | 02.1 | 100  | 99.9  | 05.2 | 60   | 159.8 | 08.4 | 20   | 219.7 | 11.5 | 80   | 279.6 | 14.7 |
| 41   | 40.9 | 02.1 | 101  | 100.9 | 05.3 | 161  | 160.8 | 08.4 | 221  | 220.7 | 11.6 | 281  | 280.6 | 14.7 |
| 42   | 41.9 | 02.2 | 02   | 101.9 | 05.3 | 62   | 161.8 | 08.5 | 22   | 221.7 | 11.6 | 82   | 281.6 | 14.8 |
| 43   | 42.9 | 02.2 | 03   | 102.9 | 05.4 | 63   | 162.8 | 08.5 | 23   | 222.7 | 11.7 | 83   | 282.6 | 14.8 |
| 44   | 43.9 | 02.3 | 04   | 103.9 | 05.4 | 64   | 163.8 | 08.6 | 24   | 223.7 | 11.7 | 84   | 283.6 | 14.9 |
| 45   | 44.9 | 02.4 | 05   | 104.9 | 05.5 | 65   | 164.8 | 08.6 | 25   | 224.7 | 11.8 | 85   | 284.6 | 14.9 |
| 46   | 45.9 | 02.4 | 06   | 105.9 | 05.5 | 66   | 165.8 | 08.7 | 26   | 225.7 | 11.8 | 86   | 285.6 | 15.0 |
| 47   | 46.9 | 02.5 | 07   | 106.9 | 05.6 | 67   | 166.8 | 08.7 | 27   | 226.7 | 11.9 | 87   | 286.6 | 15.0 |
| 48   | 47.9 | 02.5 | 08   | 107.8 | 05.7 | 68   | 167.8 | 08.8 | 28   | 227.7 | 11.9 | 88   | 287.6 | 15.1 |
| 49   | 48.9 | 02.6 | 09   | 108.8 | 05.7 | 69   | 168.8 | 08.8 | 29   | 228.7 | 12.0 | 89   | 288.6 | 15.1 |
| 50   | 49.9 | 02.6 | 10   | 109.8 | 05.8 | 70   | 169.8 | 08.9 | 30   | 229.7 | 12.0 | 90   | 289.6 | 15.2 |
| 51   | 50.9 | 02.7 | 111  | 110.8 | 05.8 | 171  | 170.8 | 09.0 | 231  | 230.7 | 12.1 | 291  | 290.6 | 15.2 |
| 52   | 51.9 | 02.7 | 12   | 111.8 | 05.9 | 72   | 171.8 | 09.0 | 32   | 231.7 | 12.1 | 92   | 291.6 | 15.3 |
| 53   | 52.9 | 02.8 | 13   | 112.8 | 05.9 | 73   | 172.8 | 09.1 | 33   | 232.7 | 12.2 | 93   | 292.6 | 15.3 |
| 54   | 53.9 | 02.8 | 14   | 113.8 | 06.0 | 74   | 173.8 | 09.1 | 34   | 233.7 | 12.2 | 94   | 293.6 | 15.4 |
| 55   | 54.9 | 02.9 | 15   | 114.8 | 06.0 | 75   | 174.8 | 09.2 | 35   | 234.7 | 12.3 | 95   | 294.6 | 15.4 |
| 56   | 55.9 | 02.9 | 16   | 115.8 | 06.1 | 76   | 175.8 | 09.2 | 36   | 235.7 | 12.3 | 96   | 295.6 | 15.5 |
| 57   | 56.9 | 03.0 | 17   | 116.8 | 06.1 | 77   | 176.8 | 09.3 | 37   | 236.7 | 12.4 | 97   | 296.6 | 15.5 |
| 58   | 57.9 | 03.0 | 18   | 117.8 | 06.2 | 78   | 177.8 | 09.3 | 38   | 237.7 | 12.5 | 98   | 297.6 | 15.6 |
| 59   | 58.9 | 03.1 | 19   | 118.8 | 06.2 | 79   | 178.8 | 09.4 | 39   | 238.7 | 12.5 | 99   | 298.6 | 15.6 |
| 60   | 59.9 | 03.1 | 120  | 119.8 | 06.3 | 180  | 179.8 | 09.4 | 140  | 239.7 | 12.6 | 300  | 299.6 | 15.7 |
| Diff | Dep  | Lat. | Diff | Dep.  | Lat. | Diff | Dep.  | Lat. | Diff | Dep.  | Lat. | Diff | Dep.  | Lat. |

Dd

for 87 Degrees.



TABLE III. Difference of Latitude and Departure for 4 Degrees.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.1 | 61   | 60.9  | 04.3 | 121  | 120.7 | 08.4 | 181  | 180.6 | 12.6 | 241  | 240.4 | 16.8 |
| 2    | 02.0 | 00.1 | 62   | 61.9  | 04.3 | 22   | 121.7 | 08.5 | 82   | 181.6 | 12.7 | 42   | 241.4 | 16.9 |
| 3    | 03.0 | 00.2 | 63   | 62.8  | 04.4 | 23   | 122.7 | 08.6 | 83   | 182.6 | 12.8 | 43   | 242.4 | 16.9 |
| 4    | 04.0 | 00.3 | 64   | 63.8  | 04.5 | 24   | 123.7 | 08.6 | 84   | 183.6 | 12.8 | 44   | 243.4 | 17.0 |
| 5    | 05.0 | 00.3 | 65   | 64.8  | 04.5 | 25   | 124.7 | 08.7 | 85   | 184.6 | 12.9 | 45   | 244.4 | 17.1 |
| 6    | 06.0 | 04.4 | 66   | 65.8  | 04.6 | 26   | 125.7 | 08.8 | 86   | 185.6 | 13.0 | 46   | 245.4 | 17.1 |
| 7    | 07.0 | 00.5 | 67   | 66.8  | 04.7 | 27   | 126.7 | 08.9 | 87   | 186.6 | 13.0 | 47   | 246.4 | 17.2 |
| 8    | 08.0 | 00.6 | 68   | 67.8  | 04.7 | 28   | 127.7 | 08.9 | 88   | 187.5 | 13.1 | 48   | 247.4 | 17.3 |
| 9    | 09.0 | 00.6 | 69   | 68.8  | 04.8 | 29   | 128.7 | 09.0 | 89   | 188.5 | 13.2 | 49   | 248.4 | 17.4 |
| 10   | 10.0 | 00.7 | 70   | 69.8  | 04.9 | 30   | 129.7 | 09.1 | 90   | 189.5 | 13.2 | 50   | 249.4 | 17.4 |
| 11   | 11.0 | 00.8 | 71   | 70.8  | 05.0 | 131  | 130.7 | 09.1 | 191  | 190.5 | 13.3 | 251  | 250.4 | 17.5 |
| 12   | 12.0 | 00.8 | 72   | 71.8  | 05.0 | 32   | 131.7 | 09.2 | 92   | 191.5 | 13.4 | 52   | 251.4 | 17.6 |
| 13   | 13.0 | 00.9 | 73   | 72.8  | 05.1 | 33   | 132.7 | 09.3 | 93   | 192.5 | 13.5 | 53   | 252.4 | 17.6 |
| 14   | 14.0 | 01.0 | 74   | 73.8  | 05.2 | 34   | 133.7 | 09.3 | 94   | 193.5 | 13.5 | 54   | 253.4 | 17.7 |
| 15   | 15.0 | 01.0 | 75   | 74.8  | 05.2 | 35   | 134.7 | 09.4 | 95   | 194.5 | 13.6 | 55   | 254.4 | 17.8 |
| 16   | 16.0 | 01.1 | 76   | 75.8  | 05.3 | 36   | 135.7 | 09.5 | 96   | 195.5 | 13.7 | 56   | 255.4 | 17.8 |
| 17   | 17.0 | 01.2 | 77   | 76.8  | 05.4 | 37   | 136.7 | 09.5 | 97   | 196.5 | 13.7 | 57   | 256.4 | 17.9 |
| 18   | 18.0 | 01.3 | 78   | 77.8  | 05.4 | 38   | 137.7 | 09.6 | 98   | 197.5 | 13.8 | 58   | 257.4 | 18.0 |
| 19   | 19.0 | 01.3 | 79   | 78.8  | 05.5 | 39   | 138.7 | 09.7 | 99   | 198.5 | 13.9 | 59   | 258.4 | 18.1 |
| 20   | 20.0 | 01.4 | 80   | 79.8  | 05.6 | 40   | 139.7 | 09.8 | 200  | 199.5 | 13.9 | 60   | 259.4 | 18.1 |
| 21   | 20.9 | 01.5 | 81   | 80.8  | 05.7 | 141  | 140.7 | 09.8 | 201  | 200.5 | 14.0 | 261  | 260.4 | 18.2 |
| 22   | 21.9 | 01.5 | 82   | 81.8  | 05.7 | 42   | 141.7 | 09.9 | 02   | 201.5 | 14.1 | 62   | 261.4 | 18.3 |
| 23   | 22.9 | 01.6 | 83   | 82.8  | 05.8 | 43   | 142.7 | 10.0 | 03   | 202.5 | 14.1 | 63   | 262.4 | 18.3 |
| 24   | 23.9 | 01.7 | 84   | 83.8  | 05.9 | 44   | 143.7 | 10.0 | 04   | 203.5 | 14.2 | 64   | 263.4 | 18.4 |
| 25   | 24.9 | 01.7 | 85   | 84.8  | 05.9 | 45   | 144.7 | 10.1 | 05   | 204.5 | 14.3 | 65   | 264.4 | 18.5 |
| 26   | 25.9 | 01.8 | 86   | 85.8  | 06.0 | 46   | 145.6 | 10.2 | 06   | 205.5 | 14.4 | 66   | 265.4 | 18.5 |
| 27   | 26.9 | 01.9 | 87   | 86.8  | 06.1 | 47   | 146.6 | 10.2 | 07   | 206.5 | 14.4 | 67   | 266.4 | 18.6 |
| 28   | 27.9 | 02.0 | 88   | 87.8  | 06.1 | 48   | 147.6 | 10.3 | 08   | 207.5 | 14.5 | 68   | 267.4 | 18.7 |
| 29   | 28.9 | 02.0 | 89   | 88.8  | 06.2 | 49   | 148.6 | 10.4 | 09   | 208.5 | 14.6 | 69   | 268.4 | 18.7 |
| 30   | 29.9 | 02.1 | 90   | 89.8  | 06.3 | 50   | 149.6 | 10.5 | 10   | 209.5 | 14.6 | 70   | 269.4 | 18.8 |
| 31   | 30.9 | 02.2 | 91   | 90.8  | 06.4 | 151  | 150.6 | 10.5 | 211  | 210.5 | 14.7 | 271  | 270.4 | 18.9 |
| 32   | 31.9 | 02.2 | 92   | 91.8  | 06.4 | 52   | 151.6 | 10.6 | 12   | 211.5 | 14.8 | 72   | 271.4 | 19.0 |
| 33   | 32.9 | 02.3 | 93   | 92.8  | 06.5 | 53   | 152.6 | 10.7 | 13   | 212.5 | 14.8 | 73   | 272.4 | 19.0 |
| 34   | 33.9 | 02.4 | 94   | 93.8  | 06.6 | 54   | 153.6 | 10.7 | 14   | 213.5 | 14.9 | 74   | 273.4 | 19.1 |
| 35   | 34.9 | 02.4 | 95   | 94.8  | 06.6 | 55   | 154.6 | 10.8 | 15   | 214.5 | 15.0 | 75   | 274.4 | 19.2 |
| 36   | 35.9 | 02.5 | 96   | 95.8  | 06.7 | 56   | 155.6 | 10.9 | 16   | 215.5 | 15.1 | 76   | 275.4 | 19.2 |
| 37   | 36.9 | 02.6 | 97   | 96.8  | 06.8 | 57   | 156.6 | 10.9 | 17   | 216.5 | 15.1 | 77   | 276.4 | 19.3 |
| 38   | 37.9 | 02.7 | 98   | 97.8  | 06.8 | 58   | 157.6 | 11.0 | 18   | 217.5 | 15.2 | 78   | 277.4 | 19.4 |
| 39   | 38.9 | 02.7 | 99   | 98.8  | 06.9 | 59   | 158.6 | 11.1 | 19   | 218.5 | 15.3 | 79   | 278.4 | 19.4 |
| 40   | 39.9 | 02.8 | 100  | 99.8  | 07.0 | 60   | 159.6 | 11.2 | 20   | 219.5 | 15.3 | 80   | 279.4 | 19.5 |
| 41   | 40.9 | 02.9 | 101  | 100.8 | 07.0 | 161  | 160.6 | 11.2 | 221  | 220.5 | 15.4 | 281  | 280.4 | 19.6 |
| 42   | 41.9 | 02.9 | 02   | 101.8 | 07.1 | 62   | 161.6 | 11.3 | 22   | 221.5 | 15.5 | 82   | 281.4 | 19.7 |
| 43   | 42.9 | 03.0 | 03   | 102.8 | 07.2 | 63   | 162.6 | 11.4 | 23   | 222.5 | 15.5 | 83   | 282.4 | 19.7 |
| 44   | 43.9 | 03.1 | 04   | 103.8 | 07.2 | 64   | 163.6 | 11.4 | 24   | 223.5 | 15.6 | 84   | 283.4 | 19.8 |
| 45   | 44.9 | 03.1 | 05   | 104.7 | 07.3 | 65   | 164.6 | 11.5 | 25   | 224.5 | 15.7 | 85   | 284.4 | 19.9 |
| 46   | 45.9 | 03.2 | 06   | 105.7 | 07.4 | 66   | 165.6 | 11.6 | 26   | 225.5 | 15.8 | 86   | 285.4 | 19.9 |
| 47   | 46.9 | 03.3 | 07   | 106.7 | 07.5 | 67   | 166.6 | 11.6 | 27   | 226.5 | 15.8 | 87   | 286.4 | 20.0 |
| 48   | 47.9 | 03.4 | 08   | 107.7 | 07.5 | 68   | 167.6 | 11.7 | 28   | 227.5 | 15.9 | 88   | 287.4 | 20.0 |
| 49   | 48.9 | 03.4 | 09   | 108.7 | 07.6 | 69   | 168.6 | 11.8 | 29   | 228.5 | 16.0 | 89   | 288.4 | 20.1 |
| 50   | 49.9 | 03.5 | 10   | 109.7 | 07.7 | 70   | 169.6 | 11.8 | 30   | 229.4 | 16.0 | 90   | 289.4 | 20.2 |
| 51   | 50.9 | 03.6 | 111  | 110.7 | 07.7 | 171  | 170.6 | 11.9 | 231  | 230.4 | 16.1 | 291  | 290.4 | 20.2 |
| 52   | 51.9 | 03.6 | 12   | 111.7 | 07.8 | 72   | 171.6 | 12.0 | 32   | 231.4 | 16.2 | 92   | 291.4 | 20.3 |
| 53   | 52.9 | 03.7 | 13   | 112.7 | 07.9 | 73   | 172.6 | 12.1 | 33   | 232.4 | 16.2 | 93   | 292.4 | 20.3 |
| 54   | 53.9 | 03.8 | 14   | 113.7 | 07.9 | 74   | 173.6 | 12.1 | 34   | 233.4 | 16.3 | 94   | 293.4 | 20.4 |
| 55   | 54.9 | 03.8 | 15   | 114.7 | 08.0 | 75   | 174.6 | 12.2 | 35   | 234.4 | 16.4 | 95   | 294.4 | 20.4 |
| 56   | 55.9 | 03.9 | 16   | 115.7 | 08.1 | 76   | 175.6 | 12.3 | 36   | 235.4 | 16.4 | 96   | 295.4 | 20.5 |
| 57   | 56.9 | 04.0 | 17   | 116.7 | 08.2 | 77   | 176.6 | 12.3 | 37   | 236.4 | 16.5 | 97   | 296.4 | 20.5 |
| 58   | 57.9 | 04.0 | 18   | 117.7 | 08.2 | 78   | 177.6 | 12.4 | 38   | 237.4 | 16.6 | 98   | 297.4 | 20.6 |
| 59   | 58.9 | 04.1 | 19   | 118.7 | 08.3 | 79   | 178.6 | 12.5 | 39   | 238.4 | 16.7 | 99   | 298.4 | 20.6 |
| 60   | 59.9 | 04.2 | 120  | 119.7 | 08.4 | 180  | 179.6 | 12.5 | 240  | 239.4 | 16.7 | 300  | 299.4 | 20.7 |
| Dist | Dep. | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat. |

for 86 Degrees.

TABLE III. Difference of Latitude and Departure for 5 Degrees.

| Dist | Lat  | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.1 | 61   | 60.8  | 05.3 | 121  | 120.5 | 10.5 | 181  | 180.3 | 15.7 | 241  | 240.1 | 21.0 |
| 2    | 02.0 | 00.2 | 62   | 61.8  | 05.4 | 22   | 121.5 | 10.6 | 82   | 181.3 | 15.8 | 42   | 241.1 | 21.1 |
| 3    | 03.0 | 00.3 | 63   | 62.8  | 05.5 | 23   | 122.5 | 10.7 | 83   | 182.3 | 15.9 | 43   | 242.1 | 21.1 |
| 4    | 04.0 | 00.3 | 64   | 63.8  | 05.6 | 24   | 123.5 | 10.8 | 84   | 183.3 | 16.0 | 44   | 243.1 | 21.2 |
| 5    | 05.0 | 00.4 | 65   | 64.8  | 05.7 | 25   | 124.5 | 10.9 | 85   | 184.3 | 16.1 | 45   | 244.1 | 21.3 |
| 6    | 06.0 | 00.5 | 66   | 65.7  | 05.8 | 26   | 125.5 | 11.0 | 86   | 185.3 | 16.2 | 46   | 245.1 | 21.4 |
| 7    | 07.0 | 00.6 | 67   | 66.7  | 05.8 | 27   | 126.5 | 11.1 | 87   | 186.3 | 16.3 | 47   | 246.1 | 21.5 |
| 8    | 08.0 | 00.7 | 68   | 67.7  | 05.9 | 28   | 127.5 | 11.2 | 88   | 187.3 | 16.4 | 48   | 247.1 | 21.6 |
| 9    | 09.0 | 00.8 | 69   | 68.7  | 06.0 | 29   | 128.5 | 11.3 | 89   | 188.3 | 16.4 | 49   | 248.1 | 21.7 |
| 10   | 10.0 | 00.9 | 70   | 69.7  | 06.1 | 30   | 129.5 | 11.4 | 90   | 189.3 | 16.5 | 50   | 249.1 | 21.8 |
| 11   | 11.0 | 01.0 | 71   | 70.7  | 06.2 | 31   | 130.5 | 11.4 | 191  | 190.3 | 16.6 | 251  | 250.0 | 21.8 |
| 12   | 12.0 | 01.0 | 72   | 71.7  | 06.3 | 32   | 131.5 | 11.5 | 92   | 191.3 | 16.7 | 52   | 251.0 | 21.9 |
| 13   | 12.9 | 01.1 | 73   | 72.7  | 06.4 | 33   | 132.5 | 11.6 | 93   | 192.3 | 16.8 | 53   | 252.0 | 22.0 |
| 14   | 13.9 | 01.2 | 74   | 73.7  | 06.5 | 34   | 133.5 | 11.7 | 94   | 193.3 | 16.9 | 54   | 253.0 | 22.1 |
| 15   | 14.9 | 01.3 | 75   | 74.7  | 06.5 | 35   | 134.5 | 11.7 | 95   | 194.3 | 17.0 | 55   | 254.0 | 22.2 |
| 16   | 15.9 | 01.4 | 76   | 75.7  | 06.6 | 36   | 135.5 | 11.8 | 96   | 195.3 | 17.1 | 56   | 255.0 | 22.3 |
| 17   | 16.9 | 01.5 | 77   | 76.7  | 06.7 | 37   | 136.5 | 11.9 | 97   | 196.3 | 17.2 | 57   | 256.0 | 22.4 |
| 18   | 17.9 | 01.6 | 78   | 77.7  | 06.8 | 38   | 137.5 | 12.0 | 98   | 197.2 | 17.3 | 58   | 257.0 | 22.4 |
| 19   | 18.9 | 01.7 | 79   | 78.7  | 06.9 | 39   | 138.5 | 12.1 | 99   | 198.2 | 17.3 | 59   | 258.0 | 22.5 |
| 20   | 19.9 | 01.7 | 80   | 79.7  | 07.0 | 40   | 139.5 | 12.2 | 200  | 199.2 | 17.4 | 60   | 259.0 | 22.6 |
| 21   | 20.9 | 01.8 | 81   | 80.7  | 07.1 | 41   | 140.5 | 12.3 | 201  | 200.2 | 17.5 | 61   | 260.0 | 22.7 |
| 22   | 21.9 | 01.9 | 82   | 81.7  | 07.2 | 42   | 141.5 | 12.4 | 02   | 201.2 | 17.6 | 62   | 261.0 | 22.8 |
| 23   | 22.9 | 02.0 | 83   | 82.7  | 07.2 | 43   | 142.5 | 12.4 | 03   | 202.2 | 17.7 | 63   | 262.0 | 22.9 |
| 24   | 23.9 | 02.1 | 84   | 83.7  | 07.3 | 44   | 143.5 | 12.5 | 04   | 203.2 | 17.7 | 64   | 263.0 | 23.0 |
| 25   | 24.9 | 02.2 | 85   | 84.7  | 07.4 | 45   | 144.4 | 12.6 | 05   | 204.2 | 17.7 | 65   | 264.0 | 23.1 |
| 26   | 25.9 | 02.3 | 86   | 85.7  | 07.5 | 46   | 145.4 | 12.7 | 06   | 205.2 | 17.9 | 66   | 265.0 | 23.1 |
| 27   | 26.9 | 02.4 | 87   | 86.7  | 07.6 | 47   | 146.4 | 12.8 | 07   | 206.2 | 18.0 | 67   | 266.0 | 23.2 |
| 28   | 27.9 | 02.4 | 88   | 87.7  | 07.7 | 48   | 147.4 | 12.9 | 08   | 207.2 | 18.1 | 68   | 267.0 | 23.3 |
| 29   | 28.9 | 02.5 | 89   | 88.7  | 07.8 | 49   | 148.4 | 13.0 | 09   | 208.2 | 18.2 | 69   | 268.0 | 23.4 |
| 30   | 29.9 | 02.6 | 90   | 89.7  | 07.8 | 50   | 149.4 | 13.1 | 10   | 209.2 | 18.3 | 70   | 269.0 | 23.5 |
| 31   | 30.9 | 02.7 | 91   | 90.7  | 07.9 | 51   | 150.4 | 13.1 | 211  | 210.2 | 18.4 | 271  | 270.0 | 23.6 |
| 32   | 31.9 | 02.8 | 92   | 91.6  | 08.0 | 52   | 151.4 | 13.2 | 12   | 211.2 | 18.4 | 72   | 271.0 | 23.7 |
| 33   | 32.9 | 02.9 | 93   | 92.6  | 08.1 | 53   | 152.4 | 13.3 | 13   | 212.2 | 18.5 | 73   | 272.0 | 23.8 |
| 34   | 33.9 | 03.0 | 94   | 93.6  | 08.2 | 54   | 153.4 | 13.4 | 14   | 213.2 | 18.6 | 74   | 273.0 | 23.8 |
| 35   | 34.9 | 03.1 | 95   | 94.6  | 08.3 | 55   | 154.4 | 13.5 | 15   | 214.2 | 18.7 | 75   | 274.0 | 23.9 |
| 36   | 35.9 | 03.1 | 96   | 95.6  | 08.4 | 56   | 155.4 | 13.6 | 16   | 215.2 | 18.8 | 76   | 275.0 | 24.0 |
| 37   | 36.9 | 03.2 | 97   | 96.6  | 08.5 | 57   | 156.4 | 13.7 | 17   | 216.2 | 18.9 | 77   | 276.0 | 24.1 |
| 38   | 37.9 | 03.3 | 98   | 97.6  | 08.5 | 58   | 157.4 | 13.7 | 18   | 217.2 | 19.0 | 78   | 277.0 | 24.2 |
| 39   | 38.9 | 03.4 | 99   | 98.6  | 08.6 | 59   | 158.4 | 13.8 | 19   | 218.2 | 19.1 | 79   | 277.9 | 24.3 |
| 40   | 39.8 | 03.5 | 100  | 99.6  | 08.7 | 60   | 159.4 | 13.9 | 20   | 219.2 | 19.1 | 80   | 278.9 | 24.4 |
| 41   | 40.8 | 03.6 | 101  | 100.6 | 08.8 | 61   | 160.4 | 14.0 | 221  | 220.2 | 19.2 | 281  | 279.9 | 24.4 |
| 42   | 41.8 | 03.7 | 02   | 101.6 | 08.9 | 62   | 161.4 | 14.1 | 22   | 221.2 | 19.3 | 82   | 280.9 | 24.5 |
| 43   | 42.8 | 03.8 | 03   | 102.6 | 09.0 | 63   | 162.4 | 14.2 | 23   | 222.2 | 19.4 | 83   | 281.9 | 24.6 |
| 44   | 43.8 | 03.8 | 04   | 103.6 | 09.0 | 64   | 163.4 | 14.3 | 24   | 223.2 | 19.5 | 84   | 282.9 | 24.7 |
| 45   | 44.8 | 03.9 | 05   | 104.6 | 09.1 | 65   | 164.4 | 14.4 | 25   | 224.2 | 19.6 | 85   | 283.9 | 24.8 |
| 46   | 45.8 | 04.0 | 06   | 105.6 | 09.2 | 66   | 165.4 | 14.4 | 26   | 225.2 | 19.7 | 86   | 284.9 | 24.9 |
| 47   | 46.8 | 04.1 | 07   | 106.6 | 09.3 | 67   | 166.4 | 14.5 | 27   | 226.2 | 19.7 | 87   | 285.9 | 25.0 |
| 48   | 47.8 | 04.2 | 08   | 107.6 | 09.4 | 68   | 167.4 | 14.6 | 28   | 227.2 | 19.8 | 88   | 286.9 | 25.1 |
| 49   | 48.8 | 04.3 | 09   | 108.6 | 09.5 | 69   | 168.4 | 14.7 | 29   | 228.2 | 19.9 | 89   | 287.9 | 25.1 |
| 50   | 49.8 | 04.4 | 10   | 109.6 | 09.6 | 70   | 169.4 | 14.8 | 30   | 229.2 | 20.0 | 90   | 288.9 | 25.2 |
| 51   | 50.8 | 04.4 | 111  | 110.6 | 09.7 | 171  | 170.4 | 14.9 | 231  | 230.2 | 20.1 | 291  | 289.9 | 25.3 |
| 52   | 51.8 | 04.5 | 12   | 111.6 | 09.7 | 72   | 171.3 | 15.0 | 32   | 231.2 | 20.2 | 92   | 290.9 | 25.4 |
| 53   | 52.8 | 04.6 | 13   | 112.6 | 09.8 | 73   | 172.3 | 15.1 | 33   | 232.2 | 20.3 | 93   | 291.9 | 25.5 |
| 54   | 53.8 | 04.7 | 14   | 113.6 | 09.9 | 74   | 173.3 | 15.1 | 34   | 233.2 | 20.4 | 94   | 292.9 | 25.6 |
| 55   | 54.8 | 04.8 | 15   | 114.6 | 10.0 | 75   | 174.3 | 15.2 | 35   | 234.2 | 20.4 | 95   | 293.9 | 25.7 |
| 56   | 55.8 | 04.9 | 16   | 115.6 | 10.1 | 76   | 175.3 | 15.3 | 36   | 235.2 | 20.5 | 96   | 294.9 | 25.8 |
| 57   | 56.8 | 05.0 | 17   | 116.6 | 10.2 | 77   | 176.3 | 15.4 | 37   | 236.2 | 20.6 | 97   | 295.9 | 25.8 |
| 58   | 57.8 | 05.1 | 18   | 117.6 | 10.3 | 78   | 177.3 | 15.5 | 38   | 237.2 | 20.7 | 98   | 296.9 | 25.9 |
| 59   | 58.8 | 05.1 | 19   | 118.5 | 10.4 | 79   | 178.3 | 15.6 | 39   | 238.2 | 20.8 | 99   | 297.9 | 26.0 |
| 60   | 59.8 | 05.2 | 120  | 119.5 | 10.4 | 180  | 179.3 | 15.7 | 240  | 239.2 | 20.9 | 300  | 298.9 | 26.1 |

D d 2

for 85 Degrees.

TABLE III. Difference of Latitude and Departure for 6 Degrees.

| Dist | Lat  | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.1 | 61   | 60.7  | 06.4 | 121  | 120.3 | 12.6 | 181  | 180.0 | 18.9 | 241  | 239.7 | 25.2 | 301  | 300.0 | 30.9 |
| 2    | 02.0 | 00.2 | 62   | 61.7  | 06.5 | 22   | 121.3 | 12.7 | 82   | 181.0 | 19.0 | 42   | 240.7 | 25.3 | 102  | 301.0 | 31.0 |
| 3    | 03.0 | 00.3 | 63   | 62.7  | 06.6 | 23   | 122.3 | 12.9 | 83   | 182.0 | 19.1 | 43   | 241.7 | 25.4 | 103  | 302.0 | 31.1 |
| 4    | 04.0 | 00.4 | 64   | 63.6  | 06.7 | 24   | 123.3 | 13.0 | 84   | 183.0 | 19.2 | 44   | 242.7 | 25.5 | 104  | 303.0 | 31.2 |
| 5    | 05.0 | 00.5 | 65   | 64.6  | 06.8 | 25   | 124.3 | 13.1 | 85   | 184.0 | 19.3 | 45   | 243.7 | 25.6 | 105  | 304.0 | 31.3 |
| 6    | 06.0 | 00.6 | 66   | 65.6  | 06.9 | 26   | 125.3 | 13.2 | 86   | 185.0 | 19.4 | 46   | 244.6 | 25.7 | 106  | 305.0 | 31.4 |
| 7    | 07.0 | 00.7 | 67   | 66.6  | 07.0 | 27   | 126.3 | 13.3 | 87   | 186.0 | 19.5 | 47   | 245.6 | 25.8 | 107  | 306.0 | 31.5 |
| 8    | 08.0 | 00.8 | 68   | 67.6  | 07.1 | 28   | 127.3 | 13.4 | 88   | 187.0 | 19.6 | 48   | 246.6 | 25.9 | 108  | 307.0 | 31.6 |
| 9    | 08.9 | 00.9 | 69   | 68.6  | 07.2 | 29   | 128.3 | 13.5 | 89   | 188.0 | 19.8 | 49   | 247.6 | 26.0 | 109  | 308.0 | 31.7 |
| 10   | 09.9 | 01.0 | 70   | 69.6  | 07.3 | 30   | 129.3 | 13.6 | 90   | 189.0 | 19.9 | 50   | 248.6 | 26.1 | 110  | 309.0 | 31.8 |
| 11   | 10.9 | 01.1 | 71   | 70.6  | 07.4 | 31   | 130.3 | 13.7 | 91   | 189.9 | 20.0 | 51   | 249.6 | 26.2 | 111  | 310.0 | 31.9 |
| 12   | 11.9 | 01.3 | 72   | 71.6  | 07.5 | 32   | 131.3 | 13.8 | 92   | 190.9 | 20.1 | 52   | 250.6 | 26.3 | 112  | 311.0 | 32.0 |
| 13   | 12.9 | 01.4 | 73   | 72.6  | 07.6 | 33   | 132.3 | 13.9 | 93   | 191.9 | 20.2 | 53   | 251.6 | 26.4 | 113  | 312.0 | 32.1 |
| 14   | 13.9 | 01.5 | 74   | 73.6  | 07.7 | 34   | 133.3 | 14.0 | 94   | 192.9 | 20.3 | 54   | 252.6 | 26.5 | 114  | 313.0 | 32.2 |
| 15   | 14.9 | 01.6 | 75   | 74.6  | 07.8 | 35   | 134.3 | 14.1 | 95   | 193.9 | 20.4 | 55   | 253.6 | 26.6 | 115  | 314.0 | 32.3 |
| 16   | 15.9 | 01.7 | 76   | 75.6  | 07.9 | 36   | 135.3 | 14.2 | 96   | 194.9 | 20.5 | 56   | 254.6 | 26.8 | 116  | 315.0 | 32.4 |
| 17   | 16.9 | 01.8 | 77   | 76.6  | 08.0 | 37   | 136.2 | 14.3 | 97   | 195.9 | 20.6 | 57   | 255.6 | 26.9 | 117  | 316.0 | 32.5 |
| 18   | 17.9 | 01.9 | 78   | 77.6  | 08.1 | 38   | 137.2 | 14.4 | 98   | 196.9 | 20.7 | 58   | 256.6 | 27.0 | 118  | 317.0 | 32.6 |
| 19   | 18.9 | 02.0 | 79   | 78.6  | 08.3 | 39   | 138.2 | 14.5 | 99   | 197.9 | 20.8 | 59   | 257.6 | 27.1 | 119  | 318.0 | 32.7 |
| 20   | 19.9 | 02.1 | 80   | 79.6  | 08.4 | 40   | 139.2 | 14.6 | 200  | 198.9 | 20.9 | 60   | 258.6 | 27.2 | 120  | 319.0 | 32.8 |
| 21   | 20.9 | 02.2 | 81   | 80.6  | 08.5 | 41   | 140.2 | 14.7 | 201  | 199.9 | 21.0 | 61   | 259.6 | 27.3 | 121  | 320.0 | 32.9 |
| 22   | 21.9 | 02.3 | 82   | 81.5  | 08.6 | 42   | 141.2 | 14.8 | 02   | 200.9 | 21.1 | 62   | 260.6 | 27.4 | 122  | 321.0 | 33.0 |
| 23   | 22.9 | 02.4 | 83   | 82.5  | 08.7 | 43   | 142.2 | 14.9 | 03   | 201.9 | 21.2 | 63   | 261.6 | 27.5 | 123  | 322.0 | 33.1 |
| 24   | 23.9 | 02.5 | 84   | 83.5  | 08.8 | 44   | 143.2 | 15.0 | 04   | 202.9 | 21.3 | 64   | 262.6 | 27.6 | 124  | 323.0 | 33.2 |
| 25   | 24.9 | 02.6 | 85   | 84.5  | 08.9 | 45   | 144.2 | 15.2 | 05   | 203.9 | 21.4 | 65   | 263.6 | 27.7 | 125  | 324.0 | 33.3 |
| 26   | 25.9 | 02.7 | 86   | 85.5  | 09.0 | 46   | 145.2 | 15.3 | 06   | 204.9 | 21.5 | 66   | 264.6 | 27.8 | 126  | 325.0 | 33.4 |
| 27   | 26.9 | 02.8 | 87   | 86.5  | 09.1 | 47   | 146.2 | 15.4 | 07   | 205.9 | 21.6 | 67   | 265.6 | 27.9 | 127  | 326.0 | 33.5 |
| 28   | 27.8 | 02.9 | 88   | 87.5  | 09.2 | 48   | 147.2 | 15.5 | 08   | 206.9 | 21.7 | 68   | 266.6 | 28.0 | 128  | 327.0 | 33.6 |
| 29   | 28.8 | 03.0 | 89   | 88.5  | 09.3 | 49   | 148.2 | 15.6 | 09   | 207.9 | 21.8 | 69   | 267.6 | 28.1 | 129  | 328.0 | 33.7 |
| 30   | 29.8 | 03.1 | 90   | 89.5  | 09.4 | 50   | 149.2 | 15.7 | 10   | 208.8 | 21.9 | 70   | 268.6 | 28.2 | 130  | 329.0 | 33.8 |
| 31   | 30.8 | 03.2 | 91   | 90.5  | 09.5 | 51   | 150.2 | 15.8 | 211  | 209.8 | 22.0 | 71   | 269.6 | 28.3 | 131  | 330.0 | 33.9 |
| 32   | 31.8 | 03.3 | 92   | 91.5  | 09.6 | 52   | 151.2 | 15.9 | 12   | 210.8 | 22.2 | 72   | 270.6 | 28.4 | 132  | 331.0 | 34.0 |
| 33   | 32.8 | 03.4 | 93   | 92.5  | 09.7 | 53   | 152.2 | 16.0 | 13   | 211.8 | 22.3 | 73   | 271.6 | 28.5 | 133  | 332.0 | 34.1 |
| 34   | 33.8 | 03.6 | 94   | 93.5  | 09.8 | 54   | 153.2 | 16.1 | 14   | 212.8 | 22.4 | 74   | 272.6 | 28.6 | 134  | 333.0 | 34.2 |
| 35   | 34.8 | 03.7 | 95   | 94.5  | 09.9 | 55   | 154.1 | 16.2 | 15   | 213.8 | 22.5 | 75   | 273.6 | 28.7 | 135  | 334.0 | 34.3 |
| 36   | 35.8 | 03.8 | 96   | 95.5  | 10.0 | 56   | 155.1 | 16.3 | 16   | 214.8 | 22.6 | 76   | 274.6 | 28.8 | 136  | 335.0 | 34.4 |
| 37   | 36.8 | 03.9 | 97   | 96.5  | 10.1 | 57   | 156.1 | 16.4 | 17   | 215.8 | 22.7 | 77   | 275.6 | 28.9 | 137  | 336.0 | 34.5 |
| 38   | 37.8 | 04.0 | 98   | 97.5  | 10.2 | 58   | 157.1 | 16.5 | 18   | 216.8 | 22.8 | 78   | 276.6 | 29.0 | 138  | 337.0 | 34.6 |
| 39   | 38.8 | 04.1 | 99   | 98.5  | 10.3 | 59   | 158.1 | 16.6 | 19   | 217.8 | 22.9 | 79   | 277.6 | 29.1 | 139  | 338.0 | 34.7 |
| 40   | 39.8 | 04.2 | 100  | 99.5  | 10.5 | 60   | 159.1 | 16.7 | 20   | 218.8 | 23.0 | 80   | 278.6 | 29.2 | 140  | 339.0 | 34.8 |
| 41   | 40.8 | 04.3 | 101  | 100.4 | 10.6 | 161  | 160.1 | 16.8 | 221  | 219.8 | 23.1 | 281  | 279.6 | 29.3 | 141  | 340.0 | 34.9 |
| 42   | 41.8 | 04.4 | 02   | 101.4 | 10.7 | 62   | 161.1 | 16.9 | 22   | 220.8 | 23.2 | 82   | 280.6 | 29.4 | 142  | 341.0 | 35.0 |
| 43   | 42.8 | 04.5 | 03   | 102.4 | 10.8 | 63   | 162.1 | 17.0 | 23   | 221.8 | 23.3 | 83   | 281.6 | 29.5 | 143  | 342.0 | 35.1 |
| 44   | 43.8 | 04.6 | 04   | 103.4 | 10.9 | 64   | 163.1 | 17.1 | 24   | 222.8 | 23.4 | 84   | 282.6 | 29.6 | 144  | 343.0 | 35.2 |
| 45   | 44.8 | 04.7 | 05   | 104.4 | 11.0 | 65   | 164.1 | 17.2 | 25   | 223.8 | 23.5 | 85   | 283.6 | 29.7 | 145  | 344.0 | 35.3 |
| 46   | 45.7 | 04.8 | 06   | 105.4 | 11.1 | 66   | 165.1 | 17.3 | 26   | 224.8 | 23.6 | 86   | 284.6 | 29.8 | 146  | 345.0 | 35.4 |
| 47   | 46.7 | 04.9 | 07   | 106.4 | 11.2 | 67   | 166.1 | 17.5 | 27   | 225.8 | 23.7 | 87   | 285.6 | 29.9 | 147  | 346.0 | 35.5 |
| 48   | 47.7 | 05.0 | 08   | 107.4 | 11.3 | 68   | 167.1 | 17.6 | 28   | 226.7 | 23.8 | 88   | 286.6 | 30.0 | 148  | 347.0 | 35.6 |
| 49   | 48.7 | 05.1 | 09   | 108.4 | 11.4 | 69   | 168.1 | 17.7 | 29   | 227.7 | 23.9 | 89   | 287.6 | 30.1 | 149  | 348.0 | 35.7 |
| 50   | 49.7 | 05.2 | 10   | 109.4 | 11.5 | 70   | 169.1 | 17.8 | 30   | 228.7 | 24.0 | 90   | 288.6 | 30.2 | 150  | 349.0 | 35.8 |
| 51   | 50.7 | 05.3 | 111  | 110.4 | 11.6 | 171  | 170.1 | 17.9 | 231  | 229.7 | 24.1 | 291  | 289.6 | 30.3 | 151  | 350.0 | 35.9 |
| 52   | 51.7 | 05.4 | 12   | 111.4 | 11.7 | 72   | 171.1 | 18.0 | 32   | 230.7 | 24.2 | 92   | 290.6 | 30.4 | 152  | 351.0 | 36.0 |
| 53   | 52.7 | 05.5 | 13   | 112.4 | 11.8 | 73   | 172.0 | 18.1 | 33   | 231.7 | 24.3 | 93   | 291.6 | 30.5 | 153  | 352.0 | 36.1 |
| 54   | 53.7 | 05.6 | 14   | 113.4 | 11.9 | 74   | 173.0 | 18.2 | 34   | 232.7 | 24.5 | 94   | 292.6 | 30.6 | 154  | 353.0 | 36.2 |
| 55   | 54.7 | 05.7 | 15   | 114.4 | 12.0 | 75   | 174.0 | 18.3 | 35   | 233.7 | 24.6 | 95   | 293.6 | 30.7 | 155  | 354.0 | 36.3 |
| 56   | 55.7 | 05.9 | 16   | 115.4 | 12.1 | 76   | 175.0 | 18.4 | 36   | 234.7 | 24.7 | 96   | 294.6 | 30.8 | 156  | 355.0 | 36.4 |
| 57   | 56.7 | 06.0 | 17   | 116.4 | 12.2 | 77   | 176.0 | 18.5 | 37   | 235.7 | 24.8 | 97   | 295.6 | 30.9 | 157  | 356.0 | 36.5 |
| 58   | 57.7 | 06.1 | 18   | 117.4 | 12.3 | 78   | 177.0 | 18.6 | 38   | 236.7 | 24.9 | 98   | 296.6 | 31.0 | 158  | 357.0 | 36.6 |
| 59   | 58.7 | 06.2 | 19   | 118.3 | 12.4 | 79   | 178.0 | 18.7 | 39   | 237.7 | 25.0 | 99   | 297.6 | 31.1 | 159  | 358.0 | 36.7 |
| 60   | 59.7 | 06.3 | 120  | 119.3 | 12.5 | 180  | 179.0 | 18.8 | 240  | 238.7 | 25.1 | 300  | 298.6 | 31.2 | 160  | 359.0 | 36.8 |
| Dist | Dep  | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat  |

for 84 Degrees.



TABLE III. Difference of Latitude and Departure for 7 Degrees.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.1 | 61   | 60.5  | 07.4 | 121  | 120.1 | 14.7 | 181  | 179.6 | 22.0 | 241  | 239.2 | 29.3 |
| 2    | 02.0 | 00.2 | 62   | 61.5  | 07.5 | 22   | 121.1 | 14.9 | 82   | 180.6 | 22.2 | 42   | 240.2 | 29.5 |
| 3    | 03.0 | 00.4 | 63   | 62.5  | 07.7 | 23   | 122.1 | 15.0 | 83   | 181.6 | 22.3 | 43   | 241.2 | 29.6 |
| 4    | 04.0 | 00.5 | 64   | 63.5  | 07.8 | 24   | 123.1 | 15.1 | 84   | 182.6 | 22.4 | 44   | 242.2 | 29.7 |
| 5    | 05.0 | 00.6 | 65   | 64.5  | 07.9 | 25   | 124.1 | 15.2 | 85   | 183.6 | 22.5 | 45   | 243.2 | 29.8 |
| 6    | 06.0 | 00.7 | 66   | 65.5  | 08.0 | 26   | 125.1 | 15.3 | 86   | 184.6 | 22.7 | 46   | 244.2 | 29.9 |
| 7    | 06.9 | 00.9 | 67   | 66.5  | 08.2 | 27   | 126.0 | 15.5 | 87   | 185.6 | 22.8 | 47   | 245.1 | 30.1 |
| 8    | 07.9 | 01.0 | 68   | 67.5  | 08.3 | 28   | 127.0 | 15.6 | 88   | 186.6 | 22.9 | 48   | 246.1 | 30.2 |
| 9    | 08.9 | 01.1 | 69   | 68.5  | 08.4 | 29   | 128.0 | 15.7 | 89   | 187.6 | 23.0 | 49   | 247.1 | 30.3 |
| 10   | 09.9 | 01.2 | 70   | 69.5  | 08.5 | 30   | 129.0 | 15.8 | 90   | 188.6 | 23.1 | 50   | 248.1 | 30.4 |
| 11   | 10.9 | 01.3 | 71   | 70.5  | 08.6 | 131  | 130.0 | 16.0 | 91   | 189.6 | 23.3 | 251  | 249.1 | 30.6 |
| 12   | 11.9 | 01.5 | 72   | 71.5  | 08.8 | 32   | 131.0 | 16.1 | 92   | 190.6 | 23.4 | 52   | 250.1 | 30.7 |
| 13   | 12.9 | 01.6 | 73   | 72.5  | 08.9 | 33   | 132.0 | 16.2 | 93   | 191.6 | 23.5 | 53   | 251.1 | 30.8 |
| 14   | 13.9 | 01.7 | 74   | 73.4  | 09.0 | 34   | 133.0 | 16.3 | 94   | 192.5 | 23.6 | 54   | 252.1 | 30.9 |
| 15   | 14.9 | 01.8 | 75   | 74.4  | 09.1 | 35   | 134.0 | 16.4 | 95   | 193.5 | 23.7 | 55   | 253.1 | 31.0 |
| 16   | 15.9 | 01.9 | 76   | 75.4  | 09.3 | 36   | 135.0 | 16.6 | 96   | 194.5 | 23.9 | 56   | 254.1 | 31.2 |
| 17   | 16.9 | 02.1 | 77   | 76.4  | 09.4 | 37   | 136.0 | 16.7 | 97   | 195.5 | 24.0 | 57   | 255.1 | 31.3 |
| 18   | 17.9 | 02.2 | 78   | 77.4  | 09.5 | 38   | 137.0 | 16.8 | 98   | 196.5 | 24.1 | 58   | 256.1 | 31.4 |
| 19   | 18.9 | 02.3 | 79   | 78.4  | 09.6 | 39   | 138.0 | 16.9 | 99   | 197.5 | 24.2 | 59   | 257.1 | 31.5 |
| 20   | 19.9 | 02.4 | 80   | 79.4  | 09.7 | 40   | 139.0 | 17.1 | 200  | 198.5 | 24.4 | 60   | 258.1 | 31.7 |
| 21   | 20.8 | 02.6 | 81   | 80.4  | 09.9 | 141  | 139.9 | 17.2 | 201  | 199.5 | 24.5 | 261  | 259.0 | 31.8 |
| 22   | 21.8 | 02.7 | 82   | 81.4  | 10.0 | 42   | 140.9 | 17.3 | 02   | 200.5 | 24.6 | 62   | 260.0 | 31.9 |
| 23   | 22.8 | 02.8 | 83   | 82.4  | 10.1 | 43   | 141.9 | 17.4 | 03   | 201.5 | 24.7 | 63   | 261.0 | 32.0 |
| 24   | 23.8 | 02.9 | 84   | 83.4  | 10.2 | 44   | 142.9 | 17.5 | 04   | 202.5 | 24.8 | 64   | 262.0 | 32.1 |
| 25   | 24.8 | 03.0 | 85   | 84.4  | 10.4 | 45   | 143.9 | 17.7 | 05   | 203.5 | 25.0 | 65   | 263.0 | 32.3 |
| 26   | 25.8 | 03.2 | 86   | 85.4  | 10.5 | 46   | 144.9 | 17.8 | 06   | 204.5 | 25.1 | 66   | 264.0 | 32.4 |
| 27   | 26.8 | 03.3 | 87   | 86.3  | 10.6 | 47   | 145.9 | 17.9 | 07   | 205.4 | 25.2 | 67   | 265.0 | 32.5 |
| 28   | 27.8 | 03.4 | 88   | 87.3  | 10.7 | 48   | 146.9 | 18.0 | 08   | 206.4 | 25.3 | 68   | 266.0 | 32.6 |
| 29   | 28.8 | 03.5 | 89   | 88.3  | 10.8 | 49   | 147.9 | 18.1 | 09   | 207.4 | 25.4 | 69   | 267.0 | 32.8 |
| 30   | 29.8 | 03.7 | 90   | 89.3  | 11.0 | 50   | 148.9 | 18.3 | 10   | 208.4 | 25.6 | 70   | 268.0 | 32.9 |
| 31   | 30.8 | 03.8 | 91   | 90.3  | 11.1 | 151  | 149.9 | 18.4 | 211  | 209.4 | 25.7 | 271  | 269.0 | 33.0 |
| 32   | 31.8 | 03.9 | 92   | 91.3  | 11.2 | 52   | 150.9 | 18.5 | 12   | 210.4 | 25.8 | 72   | 270.0 | 33.1 |
| 33   | 32.8 | 04.0 | 93   | 92.3  | 11.3 | 53   | 151.9 | 18.6 | 13   | 211.4 | 25.9 | 73   | 271.0 | 33.2 |
| 34   | 33.7 | 04.1 | 94   | 93.3  | 11.5 | 54   | 152.8 | 18.7 | 14   | 212.4 | 26.1 | 74   | 271.9 | 33.4 |
| 35   | 34.7 | 04.3 | 95   | 94.3  | 11.6 | 55   | 153.8 | 18.9 | 15   | 213.4 | 26.2 | 75   | 272.9 | 33.5 |
| 36   | 35.7 | 04.4 | 96   | 95.3  | 11.7 | 56   | 154.8 | 19.0 | 16   | 214.4 | 26.3 | 76   | 273.9 | 33.6 |
| 37   | 36.7 | 04.5 | 97   | 96.3  | 11.8 | 57   | 155.8 | 19.1 | 17   | 215.4 | 26.4 | 77   | 274.9 | 33.7 |
| 38   | 37.7 | 04.6 | 98   | 97.3  | 11.9 | 58   | 156.8 | 19.2 | 18   | 216.4 | 26.5 | 78   | 275.9 | 33.9 |
| 39   | 38.7 | 04.8 | 99   | 98.3  | 12.1 | 59   | 157.8 | 19.4 | 19   | 217.4 | 26.7 | 79   | 276.9 | 34.0 |
| 40   | 39.7 | 04.9 | 100  | 99.3  | 12.2 | 60   | 158.8 | 19.5 | 20   | 218.4 | 26.8 | 80   | 277.9 | 34.1 |
| 41   | 40.7 | 05.0 | 101  | 100.2 | 12.3 | 161  | 159.8 | 19.6 | 221  | 219.3 | 26.9 | 281  | 278.9 | 34.2 |
| 42   | 41.7 | 05.1 | 02   | 101.2 | 12.4 | 62   | 160.8 | 19.7 | 22   | 220.3 | 27.0 | 82   | 279.9 | 34.3 |
| 43   | 42.7 | 05.2 | 03   | 102.2 | 12.5 | 63   | 161.8 | 19.8 | 23   | 221.3 | 27.2 | 83   | 280.9 | 34.5 |
| 44   | 43.7 | 05.4 | 04   | 103.2 | 12.7 | 64   | 162.8 | 20.0 | 24   | 222.3 | 27.3 | 84   | 281.9 | 34.6 |
| 45   | 44.7 | 05.5 | 05   | 104.2 | 12.8 | 65   | 163.8 | 20.1 | 25   | 223.3 | 27.4 | 85   | 282.9 | 34.7 |
| 46   | 45.7 | 05.6 | 06   | 105.2 | 12.9 | 66   | 164.8 | 20.2 | 26   | 224.3 | 27.5 | 86   | 283.9 | 34.8 |
| 47   | 46.6 | 05.7 | 07   | 106.2 | 13.0 | 67   | 165.7 | 20.3 | 27   | 225.3 | 27.6 | 87   | 284.8 | 34.9 |
| 48   | 47.6 | 05.8 | 08   | 107.2 | 13.1 | 68   | 166.7 | 20.5 | 28   | 226.3 | 27.9 | 88   | 285.8 | 35.1 |
| 49   | 48.6 | 06.0 | 09   | 108.2 | 13.3 | 69   | 167.7 | 20.6 | 29   | 227.3 | 27.9 | 89   | 286.8 | 35.2 |
| 50   | 49.6 | 06.1 | 10   | 109.2 | 13.4 | 70   | 168.7 | 20.7 | 30   | 228.3 | 28.0 | 90   | 287.8 | 35.3 |
| 51   | 50.6 | 06.2 | 111  | 110.2 | 13.5 | 171  | 169.7 | 20.2 | 231  | 229.3 | 28.1 | 291  | 288.8 | 35.4 |
| 52   | 51.6 | 06.3 | 12   | 111.2 | 13.6 | 72   | 170.7 | 20.9 | 32   | 230.3 | 28.3 | 92   | 289.8 | 35.5 |
| 53   | 52.6 | 06.5 | 13   | 112.2 | 13.8 | 73   | 171.7 | 21.1 | 33   | 231.3 | 28.4 | 93   | 290.8 | 35.7 |
| 54   | 53.6 | 06.6 | 14   | 113.1 | 13.9 | 74   | 172.7 | 21.2 | 34   | 232.2 | 28.5 | 94   | 291.8 | 35.8 |
| 55   | 54.6 | 06.7 | 15   | 114.1 | 14.0 | 75   | 173.7 | 21.3 | 35   | 233.2 | 28.6 | 95   | 292.8 | 35.9 |
| 56   | 55.6 | 06.8 | 16   | 115.1 | 14.1 | 76   | 174.7 | 21.4 | 36   | 234.2 | 28.7 | 96   | 293.8 | 36.0 |
| 57   | 56.6 | 06.9 | 17   | 116.1 | 14.2 | 77   | 175.7 | 21.6 | 37   | 235.2 | 28.9 | 97   | 294.8 | 36.2 |
| 58   | 57.6 | 07.1 | 18   | 117.1 | 14.4 | 78   | 176.7 | 21.7 | 38   | 236.2 | 29.0 | 98   | 295.8 | 36.3 |
| 59   | 58.6 | 07.2 | 19   | 118.1 | 14.5 | 79   | 177.7 | 21.8 | 39   | 237.2 | 29.1 | 99   | 296.8 | 36.4 |
| 60   | 59.6 | 07.3 | 120  | 119.1 | 14.6 | 180  | 178.7 | 21.9 | 240  | 238.2 | 29.2 | 300  | 297.8 | 36.5 |
| Dist | Dep  | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat. |

for 83 Degrees.

for 83 Degrees.

TABLE III. Difference of Latitude and Departure for 8 Degrees.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.1 | 61   | 60.4  | 08.5 | 121  | 119.8 | 16.8 | 181  | 179.2 | 25.2 | 241  | 238.7 | 33.8 | 301  | 296.2 | 42.4 |
| 2    | 02.0 | 00.3 | 62   | 61.4  | 08.6 | 22   | 120.8 | 17.0 | 82   | 180.2 | 25.3 | 42   | 239.7 | 33.7 | 102  | 200.0 | 00.0 |
| 3    | 03.0 | 00.4 | 63   | 62.4  | 08.8 | 23   | 121.8 | 17.1 | 83   | 181.2 | 25.5 | 43   | 240.6 | 33.8 | 103  | 201.0 | 00.1 |
| 4    | 04.0 | 00.6 | 64   | 63.4  | 08.9 | 24   | 122.8 | 17.3 | 84   | 182.2 | 25.6 | 44   | 241.6 | 33.9 | 104  | 202.0 | 00.2 |
| 5    | 05.0 | 00.7 | 65   | 64.4  | 09.0 | 25   | 123.8 | 17.4 | 85   | 183.2 | 25.8 | 45   | 242.6 | 34.0 | 105  | 203.0 | 00.3 |
| 6    | 06.0 | 00.8 | 66   | 65.4  | 09.2 | 26   | 124.8 | 17.5 | 86   | 184.2 | 25.9 | 46   | 243.6 | 34.1 | 106  | 204.0 | 00.4 |
| 7    | 06.9 | 01.0 | 67   | 66.4  | 09.3 | 27   | 125.8 | 17.7 | 87   | 185.2 | 26.0 | 47   | 244.6 | 34.2 | 107  | 205.0 | 00.5 |
| 8    | 07.9 | 01.1 | 68   | 67.3  | 09.5 | 28   | 126.8 | 17.8 | 88   | 186.2 | 26.2 | 48   | 245.6 | 34.3 | 108  | 206.0 | 00.6 |
| 9    | 08.9 | 01.3 | 69   | 68.3  | 09.6 | 29   | 127.7 | 18.0 | 89   | 187.2 | 26.3 | 49   | 246.6 | 34.4 | 109  | 207.0 | 00.7 |
| 10   | 09.9 | 01.4 | 70   | 69.3  | 09.7 | 30   | 128.7 | 18.1 | 90   | 188.2 | 26.4 | 50   | 247.6 | 34.5 | 110  | 208.0 | 00.8 |
| 11   | 10.9 | 01.5 | 71   | 70.3  | 09.9 | 31   | 129.7 | 18.2 | 91   | 189.1 | 26.6 | 51   | 248.6 | 34.6 | 111  | 209.0 | 00.9 |
| 12   | 11.9 | 01.7 | 72   | 71.3  | 10.0 | 32   | 130.7 | 18.4 | 92   | 190.1 | 26.7 | 52   | 249.6 | 34.7 | 112  | 210.0 | 01.0 |
| 13   | 12.9 | 01.8 | 73   | 72.3  | 10.2 | 33   | 131.7 | 18.5 | 93   | 191.1 | 26.9 | 53   | 250.5 | 34.8 | 113  | 211.0 | 01.1 |
| 14   | 13.9 | 01.9 | 74   | 73.3  | 10.3 | 34   | 132.7 | 18.7 | 94   | 192.1 | 27.0 | 54   | 251.5 | 34.9 | 114  | 212.0 | 01.2 |
| 15   | 14.9 | 02.1 | 75   | 74.3  | 10.4 | 35   | 133.7 | 18.8 | 95   | 193.1 | 27.1 | 55   | 252.5 | 35.0 | 115  | 213.0 | 01.3 |
| 16   | 15.8 | 02.2 | 76   | 75.3  | 10.6 | 36   | 134.7 | 18.9 | 96   | 194.1 | 27.3 | 56   | 253.5 | 35.1 | 116  | 214.0 | 01.4 |
| 17   | 16.8 | 02.4 | 77   | 76.3  | 10.7 | 37   | 135.7 | 19.1 | 97   | 195.1 | 27.4 | 57   | 254.5 | 35.2 | 117  | 215.0 | 01.5 |
| 18   | 17.8 | 02.5 | 78   | 77.2  | 10.9 | 38   | 136.7 | 19.2 | 98   | 196.1 | 27.6 | 58   | 255.5 | 35.3 | 118  | 216.0 | 01.6 |
| 19   | 18.8 | 02.6 | 79   | 78.2  | 11.0 | 39   | 137.7 | 19.3 | 99   | 197.1 | 27.7 | 59   | 256.5 | 35.4 | 119  | 217.0 | 01.7 |
| 20   | 19.8 | 02.8 | 80   | 79.2  | 11.1 | 40   | 138.6 | 19.5 | 200  | 198.1 | 27.8 | 60   | 257.5 | 35.5 | 120  | 218.0 | 01.8 |
| 21   | 20.8 | 02.9 | 81   | 80.2  | 11.3 | 41   | 139.6 | 19.6 | 201  | 199.0 | 28.0 | 61   | 258.5 | 35.6 | 121  | 219.0 | 01.9 |
| 22   | 21.8 | 03.1 | 82   | 81.2  | 11.4 | 42   | 140.6 | 19.8 | 02   | 200.0 | 28.1 | 62   | 259.5 | 35.7 | 122  | 220.0 | 02.0 |
| 23   | 22.8 | 03.2 | 83   | 82.2  | 11.6 | 43   | 141.6 | 19.9 | 03   | 201.0 | 28.3 | 63   | 260.4 | 35.8 | 123  | 221.0 | 02.1 |
| 24   | 23.8 | 03.3 | 84   | 83.2  | 11.7 | 44   | 142.6 | 20.0 | 04   | 202.0 | 28.4 | 64   | 261.4 | 35.9 | 124  | 222.0 | 02.2 |
| 25   | 24.8 | 03.5 | 85   | 84.2  | 11.8 | 45   | 143.6 | 20.2 | 05   | 203.0 | 28.5 | 65   | 262.4 | 36.0 | 125  | 223.0 | 02.3 |
| 26   | 25.7 | 03.6 | 86   | 85.2  | 12.0 | 46   | 144.6 | 20.3 | 06   | 204.0 | 28.7 | 66   | 263.4 | 36.1 | 126  | 224.0 | 02.4 |
| 27   | 26.7 | 03.8 | 87   | 86.2  | 12.1 | 47   | 145.6 | 20.5 | 07   | 205.0 | 28.8 | 67   | 264.4 | 36.2 | 127  | 225.0 | 02.5 |
| 28   | 27.7 | 03.9 | 88   | 87.1  | 12.2 | 48   | 146.6 | 20.6 | 08   | 206.0 | 29.0 | 68   | 265.4 | 36.3 | 128  | 226.0 | 02.6 |
| 29   | 28.7 | 04.0 | 89   | 88.1  | 12.4 | 49   | 147.6 | 20.7 | 09   | 207.0 | 29.1 | 69   | 266.4 | 36.4 | 129  | 227.0 | 02.7 |
| 30   | 29.7 | 04.2 | 90   | 89.1  | 12.5 | 50   | 148.5 | 20.9 | 10   | 208.0 | 29.2 | 70   | 267.4 | 36.5 | 130  | 228.0 | 02.8 |
| 31   | 30.7 | 04.3 | 91   | 90.1  | 12.7 | 51   | 149.5 | 21.0 | 211  | 209.0 | 29.4 | 71   | 268.4 | 36.6 | 131  | 229.0 | 02.9 |
| 32   | 31.7 | 04.5 | 92   | 91.1  | 12.8 | 52   | 150.5 | 21.2 | 12   | 209.9 | 29.5 | 72   | 269.4 | 36.7 | 132  | 230.0 | 03.0 |
| 33   | 32.7 | 04.6 | 93   | 92.1  | 12.9 | 53   | 151.5 | 21.3 | 13   | 210.9 | 29.6 | 73   | 270.4 | 36.8 | 133  | 231.0 | 03.1 |
| 34   | 33.7 | 04.7 | 94   | 93.1  | 13.1 | 54   | 152.5 | 21.4 | 14   | 211.9 | 29.8 | 74   | 271.3 | 36.9 | 134  | 232.0 | 03.2 |
| 35   | 34.7 | 04.9 | 95   | 94.1  | 13.2 | 55   | 153.5 | 21.6 | 15   | 212.9 | 29.9 | 75   | 272.3 | 37.0 | 135  | 233.0 | 03.3 |
| 36   | 35.7 | 05.0 | 96   | 95.1  | 13.4 | 56   | 154.5 | 21.7 | 16   | 213.9 | 30.1 | 76   | 273.3 | 37.1 | 136  | 234.0 | 03.4 |
| 37   | 36.6 | 05.2 | 97   | 96.1  | 13.5 | 57   | 155.5 | 21.9 | 17   | 214.9 | 30.2 | 77   | 274.3 | 37.2 | 137  | 235.0 | 03.5 |
| 38   | 37.6 | 05.4 | 98   | 97.0  | 13.6 | 58   | 156.5 | 22.0 | 18   | 215.9 | 30.3 | 78   | 275.3 | 37.3 | 138  | 236.0 | 03.6 |
| 39   | 38.6 | 05.5 | 99   | 98.0  | 13.8 | 59   | 157.5 | 22.1 | 19   | 216.9 | 30.5 | 79   | 276.3 | 37.4 | 139  | 237.0 | 03.7 |
| 40   | 39.6 | 05.6 | 100  | 99.0  | 13.9 | 60   | 158.4 | 22.3 | 20   | 217.9 | 30.6 | 80   | 277.3 | 37.5 | 140  | 238.0 | 03.8 |
| 41   | 40.6 | 05.7 | 101  | 100.0 | 14.1 | 61   | 159.4 | 22.4 | 221  | 218.9 | 30.8 | 81   | 278.3 | 37.6 | 141  | 239.0 | 03.9 |
| 42   | 41.6 | 05.8 | 02   | 101.0 | 14.2 | 62   | 160.4 | 22.6 | 22   | 219.8 | 30.9 | 82   | 279.3 | 37.7 | 142  | 240.0 | 04.0 |
| 43   | 42.6 | 06.0 | 03   | 102.0 | 14.3 | 63   | 161.4 | 22.7 | 23   | 220.8 | 31.0 | 83   | 280.3 | 37.8 | 143  | 241.0 | 04.1 |
| 44   | 43.6 | 06.1 | 04   | 103.0 | 14.5 | 64   | 162.4 | 22.8 | 24   | 221.8 | 31.2 | 84   | 281.2 | 37.9 | 144  | 242.0 | 04.2 |
| 45   | 44.6 | 06.3 | 05   | 104.0 | 14.6 | 65   | 163.4 | 23.0 | 25   | 222.8 | 31.3 | 85   | 282.2 | 38.0 | 145  | 243.0 | 04.3 |
| 46   | 45.6 | 06.4 | 06   | 105.0 | 14.8 | 66   | 164.4 | 23.1 | 26   | 223.8 | 31.5 | 86   | 283.2 | 38.1 | 146  | 244.0 | 04.4 |
| 47   | 46.5 | 06.5 | 07   | 106.0 | 14.9 | 67   | 165.4 | 23.2 | 27   | 224.8 | 31.6 | 87   | 284.2 | 38.2 | 147  | 245.0 | 04.5 |
| 48   | 47.5 | 06.7 | 08   | 107.0 | 15.0 | 68   | 166.4 | 23.4 | 28   | 225.8 | 31.7 | 88   | 285.2 | 38.3 | 148  | 246.0 | 04.6 |
| 49   | 48.5 | 06.8 | 09   | 107.9 | 15.2 | 69   | 167.4 | 23.5 | 29   | 226.8 | 31.9 | 89   | 286.2 | 38.4 | 149  | 247.0 | 04.7 |
| 50   | 49.5 | 07.0 | 110  | 108.9 | 15.3 | 70   | 168.4 | 23.7 | 30   | 227.8 | 32.0 | 90   | 287.2 | 38.5 | 150  | 248.0 | 04.8 |
| 51   | 50.5 | 07.1 | 111  | 109.9 | 15.5 | 71   | 169.3 | 23.8 | 231  | 228.8 | 32.2 | 291  | 288.2 | 38.6 | 151  | 249.0 | 04.9 |
| 52   | 51.5 | 07.2 | 12   | 110.9 | 15.6 | 72   | 170.3 | 23.9 | 32   | 229.7 | 32.3 | 92   | 289.2 | 38.7 | 152  | 250.0 | 05.0 |
| 53   | 52.5 | 07.4 | 13   | 111.9 | 15.7 | 73   | 171.3 | 24.1 | 33   | 230.7 | 32.4 | 93   | 290.2 | 38.8 | 153  | 251.0 | 05.1 |
| 54   | 53.5 | 07.5 | 14   | 112.9 | 15.9 | 74   | 172.3 | 24.2 | 34   | 231.7 | 32.6 | 94   | 291.1 | 38.9 | 154  | 252.0 | 05.2 |
| 55   | 54.5 | 07.7 | 15   | 113.9 | 16.0 | 75   | 173.3 | 24.3 | 35   | 232.7 | 32.7 | 95   | 292.1 | 39.0 | 155  | 253.0 | 05.3 |
| 56   | 55.5 | 07.8 | 16   | 114.9 | 16.1 | 76   | 174.3 | 24.5 | 36   | 233.7 | 32.9 | 96   | 293.1 | 39.1 | 156  | 254.0 | 05.4 |
| 57   | 56.4 | 07.9 | 17   | 115.9 | 16.3 | 77   | 175.3 | 24.6 | 37   | 234.7 | 33.0 | 97   | 294.1 | 39.2 | 157  | 255.0 | 05.5 |
| 58   | 57.4 | 08.1 | 18   | 116.9 | 16.4 | 78   | 176.3 | 24.7 | 38   | 235.7 | 33.1 | 98   | 295.1 | 39.3 | 158  | 256.0 | 05.6 |
| 59   | 58.4 | 08.2 | 19   | 117.8 | 16.6 | 79   | 177.3 | 24.9 | 39   | 236.7 | 33.3 | 99   | 296.1 | 39.4 | 159  | 257.0 | 05.7 |
| 60   | 59.4 | 08.4 | 120  | 118.8 | 16.7 | 180  | 178.3 | 25.1 | 240  | 237.7 | 33.4 | 300  | 297.1 | 39.5 | 160  | 258.0 | 05.8 |
| Dist | Dep  | Lat. | Dist | Dep   | Lat. | Dist | Dep   | Lat. | Dist | Dep   | Lat. | Dist | Dep   | Lat. | Dist | Dep   | Lat. |

for 82 Degrees.

TABLE III. Difference of Latitude and Departure for 9 Degrees.

| Dep  | Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  |
|------|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 33.8 | 1    | 01.0 | 00.2 | 61   | 60.2  | 09.5 | 121  | 119.5 | 18.9 | 181  | 178.8 | 28.3 | 241  | 238.0 | 37.7 |
| 33.7 | 2    | 02.0 | 00.3 | 62   | 61.2  | 09.7 | 22   | 120.5 | 19.1 | 82   | 179.8 | 28.5 | 42   | 239.0 | 37.8 |
| 33.6 | 3    | 03.0 | 00.5 | 63   | 62.2  | 09.9 | 23   | 121.5 | 19.2 | 83   | 180.7 | 28.6 | 43   | 240.0 | 38.0 |
| 34.0 | 4    | 04.0 | 00.6 | 64   | 63.2  | 10.0 | 24   | 122.5 | 19.4 | 84   | 181.7 | 28.8 | 44   | 241.0 | 38.2 |
| 35.0 | 5    | 04.9 | 00.8 | 65   | 64.2  | 10.2 | 25   | 123.5 | 19.6 | 85   | 182.7 | 28.9 | 45   | 242.0 | 38.3 |
| 34.2 | 6    | 05.9 | 00.9 | 66   | 65.2  | 10.3 | 26   | 124.5 | 19.7 | 86   | 183.7 | 29.1 | 46   | 243.0 | 38.5 |
| 35.0 | 7    | 06.9 | 01.1 | 67   | 66.2  | 10.5 | 27   | 125.4 | 19.9 | 87   | 184.7 | 29.2 | 47   | 244.0 | 38.6 |
| 34.8 | 8    | 07.9 | 01.3 | 68   | 67.2  | 10.6 | 28   | 126.4 | 20.0 | 88   | 185.7 | 29.4 | 48   | 244.9 | 38.8 |
| 34.7 | 9    | 08.9 | 01.4 | 69   | 68.2  | 10.8 | 29   | 127.4 | 20.2 | 89   | 186.7 | 29.6 | 49   | 245.9 | 38.9 |
| 34.8 | 10   | 09.9 | 01.6 | 70   | 69.1  | 10.9 | 30   | 128.4 | 20.3 | 90   | 187.7 | 29.7 | 50   | 246.9 | 39.1 |
| 34.9 | 11   | 10.9 | 01.7 | 71   | 70.1  | 11.1 | 131  | 129.4 | 20.5 | 191  | 188.7 | 29.9 | 251  | 247.9 | 39.3 |
| 35.0 | 12   | 11.9 | 01.9 | 72   | 71.1  | 11.3 | 32   | 130.4 | 20.6 | 92   | 189.6 | 30.0 | 52   | 248.9 | 39.4 |
| 35.2 | 13   | 12.9 | 02.0 | 73   | 72.1  | 11.4 | 33   | 131.4 | 20.8 | 93   | 190.6 | 30.2 | 53   | 249.9 | 39.6 |
| 35.0 | 14   | 13.8 | 02.2 | 74   | 73.1  | 11.6 | 34   | 132.4 | 21.0 | 94   | 191.6 | 30.3 | 54   | 250.9 | 39.7 |
| 35.0 | 15   | 14.8 | 02.3 | 75   | 74.1  | 11.7 | 35   | 133.3 | 21.1 | 95   | 192.6 | 30.5 | 55   | 251.9 | 39.9 |
| 35.0 | 16   | 15.8 | 02.5 | 76   | 75.1  | 11.9 | 36   | 134.3 | 21.3 | 96   | 193.6 | 30.7 | 56   | 252.9 | 40.0 |
| 35.0 | 17   | 16.8 | 02.7 | 77   | 76.1  | 12.0 | 37   | 135.3 | 21.4 | 97   | 194.6 | 30.8 | 57   | 253.8 | 40.2 |
| 35.0 | 18   | 17.8 | 02.8 | 78   | 77.0  | 12.2 | 38   | 136.3 | 21.6 | 98   | 195.6 | 31.0 | 58   | 254.8 | 40.4 |
| 36.0 | 19   | 18.8 | 03.0 | 79   | 78.0  | 12.4 | 39   | 137.3 | 21.7 | 99   | 196.6 | 31.1 | 59   | 255.8 | 40.5 |
| 36.0 | 20   | 19.8 | 03.1 | 80   | 79.0  | 12.5 | 40   | 138.3 | 21.9 | 200  | 197.5 | 31.3 | 60   | 256.8 | 40.7 |
| 36.0 | 21   | 20.7 | 03.3 | 81   | 80.0  | 12.7 | 141  | 139.3 | 22.1 | 201  | 198.5 | 31.4 | 261  | 257.8 | 40.8 |
| 36.0 | 22   | 21.7 | 03.4 | 82   | 81.0  | 12.8 | 42   | 140.3 | 22.2 | 02   | 199.5 | 31.6 | 62   | 258.8 | 41.0 |
| 36.0 | 23   | 22.7 | 03.6 | 83   | 82.0  | 13.0 | 43   | 141.2 | 22.4 | 03   | 200.5 | 31.7 | 63   | 259.8 | 41.1 |
| 36.0 | 24   | 23.7 | 03.8 | 84   | 83.0  | 13.1 | 44   | 142.2 | 22.5 | 04   | 201.5 | 31.9 | 64   | 260.8 | 41.3 |
| 36.0 | 25   | 24.7 | 03.9 | 85   | 84.0  | 13.3 | 45   | 143.2 | 22.7 | 05   | 202.5 | 32.1 | 65   | 261.7 | 41.4 |
| 37.0 | 26   | 25.7 | 04.1 | 86   | 84.9  | 13.5 | 46   | 144.2 | 22.8 | 06   | 203.5 | 32.2 | 66   | 262.7 | 41.6 |
| 37.0 | 27   | 26.7 | 04.2 | 87   | 85.9  | 13.6 | 47   | 145.2 | 23.0 | 07   | 204.5 | 32.4 | 67   | 263.7 | 41.8 |
| 37.0 | 28   | 27.7 | 04.4 | 88   | 86.9  | 13.8 | 48   | 146.2 | 23.1 | 08   | 205.4 | 32.5 | 68   | 264.7 | 41.9 |
| 37.0 | 29   | 28.6 | 04.5 | 89   | 87.9  | 13.9 | 49   | 147.2 | 23.3 | 09   | 206.4 | 32.7 | 69   | 265.7 | 42.1 |
| 37.0 | 30   | 29.6 | 04.7 | 90   | 88.9  | 14.1 | 50   | 148.2 | 23.5 | 10   | 207.4 | 32.8 | 70   | 266.7 | 42.2 |
| 37.0 | 31   | 30.6 | 04.8 | 91   | 89.9  | 14.2 | 151  | 149.1 | 23.6 | 211  | 208.4 | 33.0 | 271  | 267.7 | 42.4 |
| 37.0 | 32   | 31.6 | 05.0 | 92   | 90.9  | 14.4 | 52   | 150.1 | 23.8 | 12   | 209.4 | 33.2 | 72   | 268.7 | 42.5 |
| 38.0 | 33   | 32.6 | 05.2 | 93   | 91.9  | 14.5 | 53   | 151.1 | 23.9 | 13   | 210.4 | 33.3 | 73   | 269.6 | 42.7 |
| 38.0 | 34   | 33.6 | 05.3 | 94   | 92.8  | 14.7 | 54   | 152.1 | 24.1 | 14   | 211.4 | 33.5 | 74   | 270.6 | 42.9 |
| 38.0 | 35   | 34.6 | 05.5 | 95   | 93.8  | 14.9 | 55   | 153.1 | 24.2 | 15   | 212.4 | 33.6 | 75   | 271.6 | 43.0 |
| 38.0 | 36   | 35.6 | 05.6 | 96   | 94.8  | 15.0 | 56   | 154.1 | 24.4 | 16   | 213.3 | 33.8 | 76   | 272.6 | 43.2 |
| 38.0 | 37   | 36.5 | 05.8 | 97   | 95.8  | 15.2 | 57   | 155.1 | 24.6 | 17   | 214.3 | 33.9 | 77   | 273.6 | 43.3 |
| 38.0 | 38   | 37.5 | 05.9 | 98   | 96.8  | 15.3 | 58   | 156.1 | 24.7 | 18   | 215.3 | 34.1 | 78   | 274.6 | 43.5 |
| 38.0 | 39   | 38.5 | 06.1 | 99   | 97.8  | 15.5 | 59   | 157.0 | 24.9 | 19   | 216.3 | 34.3 | 79   | 275.6 | 43.6 |
| 38.0 | 40   | 39.5 | 06.3 | 100  | 98.8  | 15.6 | 60   | 158.0 | 25.0 | 20   | 217.3 | 34.4 | 80   | 276.6 | 43.8 |
| 39.0 | 41   | 40.5 | 06.4 | 101  | 99.8  | 15.8 | 161  | 159.0 | 25.2 | 221  | 218.3 | 34.6 | 281  | 277.5 | 43.9 |
| 39.0 | 42   | 41.5 | 06.6 | 02   | 100.7 | 16.0 | 62   | 160.0 | 25.3 | 22   | 219.3 | 34.7 | 82   | 278.5 | 44.1 |
| 39.0 | 43   | 42.5 | 06.7 | 03   | 101.7 | 16.1 | 63   | 161.0 | 25.5 | 23   | 220.3 | 34.9 | 83   | 279.5 | 44.3 |
| 39.0 | 44   | 43.5 | 06.9 | 04   | 102.7 | 16.3 | 64   | 162.0 | 25.6 | 24   | 221.2 | 35.0 | 84   | 280.5 | 44.4 |
| 39.0 | 45   | 44.4 | 07.0 | 05   | 103.7 | 16.4 | 65   | 163.0 | 25.8 | 25   | 222.2 | 35.2 | 85   | 281.5 | 44.6 |
| 39.0 | 46   | 45.4 | 07.2 | 06   | 104.7 | 16.6 | 66   | 164.0 | 26.0 | 26   | 223.2 | 35.3 | 86   | 282.5 | 44.7 |
| 39.0 | 47   | 46.4 | 07.4 | 07   | 105.7 | 16.7 | 67   | 164.9 | 26.1 | 27   | 224.2 | 35.5 | 87   | 283.5 | 44.9 |
| 39.0 | 48   | 47.4 | 07.5 | 08   | 106.7 | 16.9 | 68   | 165.9 | 26.3 | 28   | 225.2 | 35.7 | 88   | 284.5 | 45.0 |
| 39.0 | 49   | 48.4 | 07.7 | 09   | 107.7 | 17.0 | 69   | 166.9 | 26.4 | 29   | 226.2 | 35.8 | 89   | 285.4 | 45.2 |
| 39.0 | 50   | 49.4 | 07.8 | 10   | 108.6 | 17.2 | 70   | 167.9 | 26.6 | 30   | 227.2 | 36.0 | 90   | 286.4 | 45.4 |
| 39.0 | 51   | 50.4 | 08.0 | 111  | 109.6 | 17.4 | 171  | 168.9 | 26.7 | 231  | 228.2 | 36.1 | 291  | 287.4 | 45.5 |
| 39.0 | 52   | 51.4 | 08.1 | 12   | 110.6 | 17.5 | 72   | 169.9 | 26.9 | 32   | 229.1 | 36.3 | 92   | 288.4 | 45.7 |
| 39.0 | 53   | 52.3 | 08.3 | 13   | 111.6 | 17.7 | 73   | 170.9 | 27.1 | 33   | 230.1 | 36.4 | 93   | 289.4 | 45.8 |
| 39.0 | 54   | 53.3 | 08.4 | 14   | 112.6 | 17.8 | 74   | 171.9 | 27.2 | 34   | 231.1 | 36.6 | 94   | 290.4 | 46.0 |
| 39.0 | 55   | 54.3 | 08.6 | 15   | 113.6 | 18.0 | 75   | 172.8 | 27.4 | 35   | 232.1 | 36.8 | 95   | 291.4 | 46.1 |
| 39.0 | 56   | 55.3 | 08.8 | 16   | 114.6 | 18.1 | 76   | 173.8 | 27.5 | 36   | 233.1 | 36.9 | 96   | 292.4 | 46.3 |
| 39.0 | 57   | 56.3 | 08.9 | 17   | 115.6 | 18.3 | 77   | 174.8 | 27.7 | 37   | 234.1 | 37.1 | 97   | 293.3 | 46.5 |
| 39.0 | 58   | 57.3 | 09.1 | 18   | 116.5 | 18.5 | 78   | 175.8 | 27.8 | 38   | 235.1 | 37.2 | 98   | 294.3 | 46.6 |
| 39.0 | 59   | 58.3 | 09.2 | 19   | 117.5 | 18.6 | 79   | 176.8 | 28.0 | 39   | 236.1 | 37.4 | 99   | 295.3 | 46.8 |
| 39.0 | 60   | 59.3 | 09.4 | 120  | 118.5 | 18.8 | 180  | 177.8 | 28.2 | 240  | 237.0 | 37.5 | 300  | 296.3 | 46.9 |

for 81 Degrees.



TABLE III. Difference of Latitude and Departure for 10 Degrees.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.2 | 61   | 60.1  | 10.6 | 121  | 119.2 | 21.0 | 181  | 178.2 | 31.4 | 241  | 237.3 | 41.8 | 291  | 233.3 | 52.2 |
| 2    | 02.0 | 00.3 | 62   | 61.1  | 10.8 | 22   | 120.1 | 21.2 | 82   | 179.2 | 31.6 | 22   | 234.3 | 42.0 | 82   | 234.3 | 52.4 |
| 3    | 03.0 | 00.5 | 63   | 62.0  | 10.9 | 23   | 121.1 | 21.3 | 83   | 180.2 | 31.7 | 23   | 235.3 | 42.1 | 83   | 235.3 | 52.5 |
| 4    | 04.0 | 00.7 | 64   | 63.0  | 11.1 | 24   | 122.1 | 21.5 | 84   | 181.2 | 31.9 | 24   | 236.3 | 42.2 | 84   | 236.3 | 52.6 |
| 5    | 05.0 | 00.9 | 65   | 64.0  | 11.2 | 25   | 123.1 | 21.7 | 85   | 182.2 | 32.1 | 25   | 237.3 | 42.3 | 85   | 237.3 | 52.7 |
| 6    | 06.0 | 01.0 | 66   | 65.0  | 11.4 | 26   | 124.1 | 21.8 | 86   | 183.2 | 32.3 | 26   | 238.3 | 42.4 | 86   | 238.3 | 52.8 |
| 7    | 07.0 | 01.2 | 67   | 66.0  | 11.6 | 27   | 125.1 | 22.0 | 87   | 184.2 | 32.4 | 27   | 239.3 | 42.5 | 87   | 239.3 | 52.9 |
| 8    | 08.0 | 01.4 | 68   | 67.0  | 11.8 | 28   | 126.1 | 22.2 | 88   | 185.1 | 32.6 | 28   | 240.3 | 42.6 | 88   | 240.3 | 53.0 |
| 9    | 09.0 | 01.6 | 69   | 68.0  | 12.0 | 29   | 127.0 | 22.4 | 89   | 186.1 | 32.8 | 29   | 241.3 | 42.7 | 89   | 241.3 | 53.1 |
| 10   | 10.0 | 01.7 | 70   | 68.9  | 12.1 | 30   | 128.0 | 22.5 | 90   | 187.1 | 32.9 | 30   | 242.3 | 42.8 | 90   | 242.3 | 53.2 |
| 11   | 11.0 | 01.9 | 71   | 69.9  | 12.3 | 31   | 129.0 | 22.7 | 91   | 188.1 | 33.1 | 31   | 243.3 | 42.9 | 91   | 243.3 | 53.3 |
| 12   | 12.0 | 02.1 | 72   | 70.9  | 12.5 | 32   | 130.0 | 22.9 | 92   | 189.1 | 33.3 | 32   | 244.3 | 43.0 | 92   | 244.3 | 53.4 |
| 13   | 13.0 | 02.3 | 73   | 71.9  | 12.7 | 33   | 131.0 | 23.1 | 93   | 190.1 | 33.5 | 33   | 245.3 | 43.1 | 93   | 245.3 | 53.5 |
| 14   | 14.0 | 02.4 | 74   | 72.9  | 12.8 | 34   | 132.0 | 23.2 | 94   | 191.0 | 33.6 | 34   | 246.3 | 43.2 | 94   | 246.3 | 53.6 |
| 15   | 15.0 | 02.6 | 75   | 73.9  | 13.0 | 35   | 132.9 | 23.4 | 95   | 192.0 | 33.8 | 35   | 247.3 | 43.3 | 95   | 247.3 | 53.7 |
| 16   | 16.0 | 02.8 | 76   | 74.8  | 13.2 | 36   | 133.9 | 23.6 | 96   | 193.0 | 34.0 | 36   | 248.3 | 43.4 | 96   | 248.3 | 53.8 |
| 17   | 17.0 | 02.9 | 77   | 75.8  | 13.4 | 37   | 134.9 | 23.8 | 97   | 194.0 | 34.2 | 37   | 249.3 | 43.5 | 97   | 249.3 | 53.9 |
| 18   | 18.0 | 03.1 | 78   | 76.8  | 13.5 | 38   | 135.9 | 23.9 | 98   | 195.0 | 34.3 | 38   | 250.3 | 43.6 | 98   | 250.3 | 54.0 |
| 19   | 19.0 | 03.3 | 79   | 77.8  | 13.7 | 39   | 136.9 | 24.1 | 99   | 196.0 | 34.5 | 39   | 251.3 | 43.7 | 99   | 251.3 | 54.1 |
| 20   | 20.0 | 03.5 | 80   | 78.8  | 13.9 | 40   | 137.9 | 24.3 | 200  | 197.0 | 34.7 | 40   | 252.3 | 43.8 | 200  | 197.0 | 54.2 |
| 21   | 21.0 | 03.6 | 81   | 79.8  | 14.0 | 41   | 138.9 | 24.4 | 201  | 197.9 | 34.9 | 41   | 253.3 | 43.9 | 201  | 197.9 | 54.3 |
| 22   | 22.0 | 03.8 | 82   | 80.8  | 14.2 | 42   | 139.8 | 24.6 | 202  | 198.9 | 35.0 | 42   | 254.3 | 44.0 | 202  | 198.9 | 54.4 |
| 23   | 23.0 | 04.0 | 83   | 81.7  | 14.4 | 43   | 140.8 | 24.8 | 203  | 199.9 | 35.2 | 43   | 255.3 | 44.1 | 203  | 199.9 | 54.5 |
| 24   | 24.0 | 04.2 | 84   | 82.7  | 14.6 | 44   | 141.8 | 25.0 | 204  | 200.9 | 35.4 | 44   | 256.3 | 44.2 | 204  | 200.9 | 54.6 |
| 25   | 25.0 | 04.3 | 85   | 83.7  | 14.7 | 45   | 142.8 | 25.1 | 205  | 201.9 | 35.5 | 45   | 257.3 | 44.3 | 205  | 201.9 | 54.7 |
| 26   | 26.0 | 04.5 | 86   | 84.7  | 14.9 | 46   | 143.8 | 25.3 | 206  | 202.9 | 35.7 | 46   | 258.3 | 44.4 | 206  | 202.9 | 54.8 |
| 27   | 27.0 | 04.7 | 87   | 85.7  | 15.1 | 47   | 144.8 | 25.5 | 207  | 203.9 | 35.9 | 47   | 259.3 | 44.5 | 207  | 203.9 | 54.9 |
| 28   | 28.0 | 04.9 | 88   | 86.7  | 15.3 | 48   | 145.7 | 25.7 | 208  | 204.8 | 36.1 | 48   | 260.3 | 44.6 | 208  | 204.8 | 55.0 |
| 29   | 29.0 | 05.0 | 89   | 87.6  | 15.4 | 49   | 146.7 | 25.8 | 209  | 205.8 | 36.2 | 49   | 261.3 | 44.7 | 209  | 205.8 | 55.1 |
| 30   | 30.0 | 05.2 | 90   | 88.6  | 15.6 | 50   | 147.7 | 26.0 | 210  | 206.8 | 36.4 | 50   | 262.3 | 44.8 | 210  | 206.8 | 55.2 |
| 31   | 31.0 | 05.4 | 91   | 89.6  | 15.8 | 51   | 148.7 | 26.2 | 211  | 207.8 | 36.6 | 51   | 263.3 | 44.9 | 211  | 207.8 | 55.3 |
| 32   | 32.0 | 05.5 | 92   | 90.6  | 16.0 | 52   | 149.7 | 26.4 | 212  | 208.8 | 36.8 | 52   | 264.3 | 45.0 | 212  | 208.8 | 55.4 |
| 33   | 33.0 | 05.7 | 93   | 91.6  | 16.1 | 53   | 150.7 | 26.5 | 213  | 209.8 | 36.9 | 53   | 265.3 | 45.1 | 213  | 209.8 | 55.5 |
| 34   | 34.0 | 05.9 | 94   | 92.6  | 16.3 | 54   | 151.7 | 26.7 | 214  | 210.7 | 37.1 | 54   | 266.3 | 45.2 | 214  | 210.7 | 55.6 |
| 35   | 35.0 | 06.1 | 95   | 93.6  | 16.5 | 55   | 152.6 | 26.9 | 215  | 211.7 | 37.3 | 55   | 267.3 | 45.3 | 215  | 211.7 | 55.7 |
| 36   | 36.0 | 06.2 | 96   | 94.5  | 16.6 | 56   | 153.6 | 27.1 | 216  | 212.7 | 37.5 | 56   | 268.3 | 45.4 | 216  | 212.7 | 55.8 |
| 37   | 37.0 | 06.4 | 97   | 95.5  | 16.8 | 57   | 154.6 | 27.2 | 217  | 213.7 | 37.6 | 57   | 269.3 | 45.5 | 217  | 213.7 | 55.9 |
| 38   | 38.0 | 06.6 | 98   | 96.5  | 17.0 | 58   | 155.6 | 27.4 | 218  | 214.7 | 37.8 | 58   | 270.3 | 45.6 | 218  | 214.7 | 56.0 |
| 39   | 39.0 | 06.8 | 99   | 97.5  | 17.2 | 59   | 156.6 | 27.6 | 219  | 215.7 | 38.0 | 59   | 271.3 | 45.7 | 219  | 215.7 | 56.1 |
| 40   | 40.0 | 06.9 | 100  | 98.5  | 17.3 | 60   | 157.6 | 27.7 | 220  | 216.7 | 38.1 | 60   | 272.3 | 45.8 | 220  | 216.7 | 56.2 |
| 41   | 41.0 | 07.1 | 101  | 99.5  | 17.5 | 161  | 158.6 | 27.9 | 221  | 217.6 | 38.3 | 281  | 273.3 | 45.9 | 221  | 217.6 | 56.3 |
| 42   | 42.0 | 07.3 | 102  | 100.4 | 17.7 | 62   | 159.5 | 28.1 | 222  | 218.6 | 38.5 | 82   | 274.3 | 46.0 | 222  | 218.6 | 56.4 |
| 43   | 43.0 | 07.5 | 103  | 101.4 | 17.9 | 63   | 160.5 | 28.3 | 223  | 219.6 | 38.7 | 83   | 275.3 | 46.1 | 223  | 219.6 | 56.5 |
| 44   | 44.0 | 07.6 | 104  | 102.4 | 18.0 | 64   | 161.5 | 28.4 | 224  | 220.6 | 38.8 | 84   | 276.3 | 46.2 | 224  | 220.6 | 56.6 |
| 45   | 45.0 | 07.8 | 105  | 103.4 | 18.2 | 65   | 162.5 | 28.6 | 225  | 221.6 | 39.0 | 85   | 277.3 | 46.3 | 225  | 221.6 | 56.7 |
| 46   | 46.0 | 08.0 | 106  | 104.4 | 18.4 | 66   | 163.5 | 28.8 | 226  | 222.6 | 39.2 | 86   | 278.3 | 46.4 | 226  | 222.6 | 56.8 |
| 47   | 47.0 | 08.1 | 107  | 105.4 | 18.6 | 67   | 164.5 | 29.0 | 227  | 223.5 | 39.4 | 87   | 279.3 | 46.5 | 227  | 223.5 | 56.9 |
| 48   | 48.0 | 08.3 | 108  | 106.4 | 18.7 | 68   | 165.4 | 29.1 | 228  | 224.5 | 39.5 | 88   | 280.3 | 46.6 | 228  | 224.5 | 57.0 |
| 49   | 49.0 | 08.5 | 109  | 107.3 | 18.9 | 69   | 166.4 | 29.3 | 229  | 225.5 | 39.7 | 89   | 281.3 | 46.7 | 229  | 225.5 | 57.1 |
| 50   | 50.0 | 08.7 | 110  | 108.3 | 19.1 | 70   | 167.4 | 29.5 | 230  | 226.5 | 39.9 | 90   | 282.3 | 46.8 | 230  | 226.5 | 57.2 |
| 51   | 51.0 | 08.8 | 111  | 109.3 | 19.2 | 171  | 168.4 | 29.7 | 231  | 227.5 | 40.1 | 291  | 283.3 | 46.9 | 231  | 227.5 | 57.3 |
| 52   | 52.0 | 09.0 | 112  | 110.3 | 19.4 | 72   | 169.4 | 29.8 | 232  | 228.5 | 40.2 | 92   | 284.3 | 47.0 | 232  | 228.5 | 57.4 |
| 53   | 53.0 | 09.2 | 113  | 111.3 | 19.6 | 73   | 170.4 | 30.0 | 233  | 229.5 | 40.4 | 93   | 285.3 | 47.1 | 233  | 229.5 | 57.5 |
| 54   | 54.0 | 09.4 | 114  | 112.3 | 19.8 | 74   | 171.4 | 30.2 | 234  | 230.4 | 40.6 | 94   | 286.3 | 47.2 | 234  | 230.4 | 57.6 |
| 55   | 55.0 | 09.5 | 115  | 113.3 | 19.9 | 75   | 172.3 | 30.3 | 235  | 231.4 | 40.7 | 95   | 287.3 | 47.3 | 235  | 231.4 | 57.7 |
| 56   | 56.0 | 09.7 | 116  | 114.2 | 20.1 | 76   | 173.3 | 30.5 | 236  | 232.4 | 40.9 | 96   | 288.3 | 47.4 | 236  | 232.4 | 57.8 |
| 57   | 57.0 | 09.9 | 117  | 115.2 | 20.3 | 77   | 174.3 | 30.7 | 237  | 233.4 | 41.1 | 97   | 289.3 | 47.5 | 237  | 233.4 | 57.9 |
| 58   | 58.0 | 10.1 | 118  | 116.2 | 20.5 | 78   | 175.3 | 30.9 | 238  | 234.4 | 41.3 | 98   | 290.3 | 47.6 | 238  | 234.4 | 58.0 |
| 59   | 59.0 | 10.2 | 119  | 117.2 | 20.6 | 79   | 176.3 | 31.0 | 239  | 235.4 | 41.4 | 99   | 291.3 | 47.7 | 239  | 235.4 | 58.1 |
| 60   | 60.0 | 10.4 | 120  | 118.2 | 20.8 | 180  | 177.3 | 31.2 | 240  | 236.4 | 41.6 | 300  | 292.3 | 47.8 | 240  | 236.4 | 58.2 |
| Dist | Dep  | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat  |

for 80 Degrees.

TABLE III. Difference of Latitude and Departure for 11 Degrees.

| Diff | Lat. | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.2 | 61   | 59.9  | 11.6 | 121  | 118.8 | 23.1 | 181  | 177.7 | 34.5 | 241  | 236.6 | 46.0 |
| 2    | 02.0 | 00.4 | 62   | 60.9  | 11.8 | 22   | 119.8 | 23.3 | 82   | 178.6 | 34.7 | 42   | 237.5 | 46.2 |
| 3    | 02.9 | 00.6 | 63   | 61.8  | 12.0 | 23   | 120.7 | 23.5 | 83   | 179.6 | 34.9 | 43   | 238.5 | 46.4 |
| 4    | 03.9 | 00.8 | 64   | 62.8  | 12.2 | 24   | 121.7 | 23.7 | 84   | 180.6 | 35.1 | 44   | 239.5 | 46.6 |
| 5    | 04.9 | 01.0 | 65   | 63.8  | 12.4 | 25   | 122.7 | 23.9 | 85   | 181.6 | 35.3 | 45   | 240.5 | 46.8 |
| 6    | 05.9 | 01.1 | 66   | 64.8  | 12.6 | 26   | 123.7 | 24.0 | 86   | 182.6 | 35.5 | 46   | 241.5 | 47.0 |
| 7    | 06.9 | 01.3 | 67   | 65.8  | 12.8 | 27   | 124.7 | 24.2 | 87   | 183.6 | 35.7 | 47   | 242.5 | 47.1 |
| 8    | 07.9 | 01.5 | 68   | 66.7  | 13.0 | 28   | 125.6 | 24.4 | 88   | 184.5 | 35.9 | 48   | 243.4 | 47.3 |
| 9    | 08.8 | 01.7 | 69   | 67.7  | 13.2 | 29   | 126.6 | 24.6 | 89   | 185.5 | 36.1 | 49   | 244.4 | 47.5 |
| 10   | 09.8 | 01.9 | 70   | 68.7  | 13.4 | 30   | 127.6 | 24.8 | 90   | 186.5 | 36.3 | 50   | 245.4 | 47.7 |
| 11   | 10.8 | 02.1 | 71   | 69.7  | 13.5 | 131  | 128.6 | 25.0 | 191  | 187.5 | 36.4 | 251  | 246.4 | 47.9 |
| 12   | 11.8 | 02.3 | 72   | 70.7  | 13.7 | 32   | 129.6 | 25.2 | 92   | 188.5 | 36.6 | 52   | 247.4 | 48.1 |
| 13   | 12.8 | 02.5 | 73   | 71.7  | 13.9 | 33   | 130.6 | 25.4 | 93   | 189.4 | 36.8 | 53   | 248.3 | 48.3 |
| 14   | 13.7 | 02.7 | 74   | 72.6  | 14.1 | 34   | 131.5 | 25.6 | 94   | 190.4 | 37.0 | 54   | 249.3 | 48.5 |
| 15   | 14.7 | 02.9 | 75   | 73.6  | 14.3 | 35   | 132.5 | 25.8 | 95   | 191.4 | 37.2 | 55   | 250.3 | 48.7 |
| 16   | 15.7 | 03.1 | 76   | 74.6  | 14.5 | 36   | 133.5 | 25.9 | 96   | 192.4 | 37.4 | 56   | 251.3 | 48.8 |
| 17   | 16.7 | 03.2 | 77   | 75.6  | 14.7 | 37   | 134.5 | 26.1 | 97   | 193.4 | 37.6 | 57   | 252.3 | 49.0 |
| 18   | 17.7 | 03.4 | 78   | 76.6  | 14.9 | 38   | 135.5 | 26.3 | 98   | 194.4 | 37.8 | 58   | 253.2 | 49.2 |
| 19   | 18.7 | 03.6 | 79   | 77.5  | 15.1 | 39   | 136.4 | 26.5 | 99   | 195.3 | 38.0 | 59   | 254.2 | 49.4 |
| 20   | 19.6 | 03.8 | 80   | 78.5  | 15.3 | 40   | 137.4 | 26.7 | 200  | 196.3 | 38.2 | 60   | 255.2 | 49.6 |
| 21   | 20.6 | 04.0 | 81   | 79.5  | 15.5 | 41   | 138.4 | 26.9 | 201  | 197.3 | 38.4 | 261  | 256.2 | 49.8 |
| 22   | 21.6 | 04.2 | 82   | 80.5  | 15.6 | 42   | 139.4 | 27.1 | 02   | 198.3 | 38.5 | 62   | 257.2 | 50.0 |
| 23   | 22.6 | 04.4 | 83   | 81.5  | 15.8 | 43   | 140.4 | 27.3 | 03   | 199.3 | 38.7 | 63   | 258.2 | 50.2 |
| 24   | 23.6 | 04.6 | 84   | 82.5  | 16.0 | 44   | 141.3 | 27.5 | 04   | 200.2 | 38.9 | 64   | 259.1 | 50.4 |
| 25   | 24.5 | 04.8 | 85   | 83.4  | 16.2 | 45   | 142.3 | 27.7 | 05   | 201.2 | 39.1 | 65   | 260.1 | 50.6 |
| 26   | 25.5 | 05.0 | 86   | 84.4  | 16.4 | 46   | 143.3 | 27.9 | 06   | 202.2 | 39.3 | 66   | 261.1 | 50.8 |
| 27   | 26.5 | 05.2 | 87   | 85.4  | 16.6 | 47   | 144.3 | 28.0 | 07   | 203.2 | 39.5 | 67   | 262.1 | 50.9 |
| 28   | 27.5 | 05.3 | 88   | 86.4  | 16.8 | 48   | 145.3 | 28.2 | 08   | 204.2 | 39.7 | 68   | 263.1 | 51.1 |
| 29   | 28.5 | 05.5 | 89   | 87.4  | 17.0 | 49   | 146.3 | 28.4 | 09   | 205.2 | 39.9 | 69   | 264.0 | 51.3 |
| 30   | 29.4 | 05.7 | 90   | 88.3  | 17.2 | 50   | 147.2 | 28.6 | 10   | 206.1 | 40.1 | 70   | 265.0 | 51.5 |
| 31   | 30.4 | 05.9 | 91   | 89.3  | 17.4 | 151  | 148.2 | 28.8 | 211  | 207.1 | 40.3 | 271  | 266.0 | 51.7 |
| 32   | 31.4 | 06.1 | 92   | 90.3  | 17.6 | 52   | 149.2 | 29.0 | 12   | 208.1 | 40.4 | 72   | 267.0 | 51.9 |
| 33   | 32.4 | 06.3 | 93   | 91.3  | 17.7 | 53   | 150.2 | 29.2 | 13   | 209.1 | 40.6 | 73   | 268.0 | 52.1 |
| 34   | 33.4 | 06.5 | 94   | 92.3  | 17.9 | 54   | 151.2 | 29.4 | 14   | 210.1 | 40.8 | 74   | 269.0 | 52.3 |
| 35   | 34.4 | 06.7 | 95   | 93.3  | 18.1 | 55   | 152.1 | 29.6 | 15   | 211.0 | 41.0 | 75   | 269.9 | 52.5 |
| 36   | 35.3 | 06.9 | 96   | 94.2  | 18.3 | 56   | 153.1 | 29.8 | 16   | 212.0 | 41.2 | 76   | 270.9 | 52.7 |
| 37   | 36.3 | 07.1 | 97   | 95.2  | 18.5 | 57   | 154.1 | 30.0 | 17   | 213.0 | 41.4 | 77   | 271.9 | 52.9 |
| 38   | 37.3 | 07.3 | 98   | 96.2  | 18.7 | 58   | 155.1 | 30.1 | 18   | 214.0 | 41.6 | 78   | 272.9 | 53.0 |
| 39   | 38.3 | 07.4 | 99   | 97.2  | 18.9 | 59   | 156.1 | 30.3 | 19   | 215.0 | 41.8 | 79   | 273.9 | 53.2 |
| 40   | 39.3 | 07.6 | 100  | 98.2  | 19.1 | 60   | 157.1 | 30.5 | 20   | 215.9 | 42.0 | 80   | 274.8 | 53.4 |
| 41   | 40.2 | 07.8 | 101  | 99.1  | 19.3 | 161  | 158.0 | 30.7 | 221  | 216.9 | 42.2 | 281  | 275.8 | 53.6 |
| 42   | 41.2 | 08.0 | 02   | 100.1 | 19.5 | 62   | 159.0 | 30.9 | 22   | 217.9 | 42.4 | 82   | 276.8 | 53.8 |
| 43   | 42.2 | 08.2 | 03   | 101.1 | 19.7 | 63   | 160.0 | 31.1 | 23   | 218.9 | 42.5 | 83   | 277.8 | 54.0 |
| 44   | 43.2 | 08.4 | 04   | 102.1 | 19.8 | 64   | 161.0 | 31.3 | 24   | 219.9 | 42.7 | 84   | 278.8 | 54.2 |
| 45   | 44.2 | 08.6 | 05   | 103.1 | 20.0 | 65   | 162.0 | 31.5 | 25   | 220.9 | 42.9 | 85   | 279.8 | 54.4 |
| 46   | 45.2 | 08.8 | 06   | 104.0 | 20.2 | 66   | 162.9 | 31.7 | 26   | 221.8 | 43.1 | 86   | 280.7 | 54.6 |
| 47   | 46.1 | 09.0 | 07   | 105.0 | 20.4 | 67   | 163.9 | 31.9 | 27   | 222.8 | 43.3 | 87   | 281.7 | 54.8 |
| 48   | 47.1 | 09.2 | 08   | 106.0 | 20.6 | 68   | 164.9 | 32.1 | 28   | 223.8 | 43.5 | 88   | 282.7 | 55.0 |
| 49   | 48.1 | 09.3 | 09   | 107.0 | 20.8 | 69   | 165.9 | 32.2 | 29   | 224.8 | 43.7 | 89   | 283.7 | 55.1 |
| 50   | 49.1 | 09.5 | 10   | 108.0 | 21.0 | 70   | 166.9 | 32.4 | 30   | 225.8 | 43.9 | 90   | 284.7 | 55.3 |
| 51   | 50.1 | 09.7 | 111  | 109.0 | 21.2 | 171  | 167.9 | 32.6 | 231  | 226.7 | 44.1 | 291  | 285.6 | 55.5 |
| 52   | 51.0 | 09.9 | 12   | 109.9 | 21.4 | 72   | 168.8 | 32.8 | 32   | 227.7 | 44.3 | 92   | 286.6 | 55.7 |
| 53   | 52.0 | 10.1 | 13   | 110.9 | 21.6 | 73   | 169.8 | 33.0 | 33   | 228.7 | 44.5 | 93   | 287.6 | 55.9 |
| 54   | 53.0 | 10.3 | 14   | 111.9 | 21.8 | 74   | 170.8 | 33.2 | 34   | 229.7 | 44.6 | 94   | 288.6 | 56.0 |
| 55   | 54.0 | 10.5 | 15   | 112.9 | 21.9 | 75   | 171.8 | 33.4 | 35   | 230.7 | 44.8 | 95   | 289.6 | 56.3 |
| 56   | 55.0 | 10.7 | 16   | 113.9 | 22.1 | 76   | 172.8 | 33.6 | 36   | 231.7 | 45.0 | 96   | 290.5 | 56.5 |
| 57   | 56.0 | 10.9 | 17   | 114.8 | 22.3 | 77   | 173.7 | 33.8 | 37   | 232.6 | 45.2 | 97   | 291.5 | 56.7 |
| 58   | 56.9 | 11.1 | 18   | 115.8 | 22.5 | 78   | 174.7 | 34.0 | 38   | 233.6 | 45.4 | 98   | 292.5 | 56.9 |
| 59   | 57.9 | 11.3 | 19   | 116.8 | 22.7 | 79   | 175.7 | 34.2 | 39   | 234.6 | 45.6 | 99   | 293.5 | 57.0 |
| 60   | 58.9 | 11.4 | 120  | 117.8 | 22.9 | 180  | 176.7 | 34.3 | 240  | 235.6 | 45.8 | 300  | 294.5 | 57.2 |

E e

for 79 Degrees

TABLE III. Difference of Latitude and Departure for 12 Degrees.

| Dist | Lat  | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.2 | 61   | 59.7  | 12.7 | 121  | 118.3 | 25.2 | 181  | 177.0 | 37.6 | 241  | 235.7 | 50.1 |
| 2    | 02.0 | 00.4 | 62   | 60.6  | 12.9 | 22   | 119.3 | 25.4 | 82   | 178.0 | 37.9 | 42   | 236.7 | 50.3 |
| 3    | 02.9 | 00.6 | 63   | 61.6  | 13.1 | 23   | 120.3 | 25.6 | 83   | 179.0 | 38.1 | 43   | 237.7 | 50.5 |
| 4    | 03.9 | 00.8 | 64   | 62.6  | 13.3 | 24   | 121.3 | 25.8 | 84   | 180.0 | 38.3 | 44   | 238.6 | 50.8 |
| 5    | 04.9 | 01.0 | 65   | 63.6  | 13.5 | 25   | 122.3 | 26.0 | 85   | 180.9 | 38.5 | 45   | 239.6 | 51.0 |
| 6    | 05.9 | 01.2 | 66   | 64.5  | 13.7 | 26   | 123.2 | 26.2 | 86   | 181.9 | 38.7 | 46   | 240.6 | 51.2 |
| 7    | 06.8 | 01.5 | 67   | 65.5  | 13.9 | 27   | 124.2 | 26.4 | 87   | 182.9 | 38.9 | 47   | 241.6 | 51.4 |
| 8    | 07.8 | 01.7 | 68   | 66.5  | 14.1 | 28   | 125.2 | 26.6 | 88   | 183.9 | 39.1 | 48   | 242.5 | 51.6 |
| 9    | 08.8 | 01.9 | 69   | 67.5  | 14.4 | 29   | 126.2 | 26.8 | 89   | 184.8 | 39.3 | 49   | 243.5 | 51.8 |
| 10   | 09.8 | 02.1 | 70   | 68.5  | 14.6 | 30   | 127.1 | 27.0 | 90   | 185.8 | 39.5 | 50   | 244.5 | 52.0 |
| 11   | 10.8 | 02.3 | 71   | 69.4  | 14.8 | 31   | 128.1 | 27.2 | 91   | 186.8 | 39.7 | 51   | 245.5 | 52.2 |
| 12   | 11.7 | 02.5 | 72   | 70.4  | 15.0 | 32   | 129.1 | 27.5 | 92   | 187.8 | 39.9 | 52   | 246.5 | 52.4 |
| 13   | 12.7 | 02.7 | 73   | 71.4  | 15.2 | 33   | 130.1 | 27.7 | 93   | 188.8 | 40.1 | 53   | 247.4 | 52.6 |
| 14   | 13.7 | 02.9 | 74   | 72.4  | 15.4 | 34   | 131.1 | 27.9 | 94   | 189.7 | 40.4 | 54   | 248.4 | 52.8 |
| 15   | 14.7 | 03.1 | 75   | 73.4  | 15.6 | 35   | 132.0 | 28.1 | 95   | 190.7 | 40.6 | 55   | 249.4 | 53.0 |
| 16   | 15.6 | 03.3 | 76   | 74.3  | 15.8 | 36   | 133.0 | 28.3 | 96   | 191.7 | 40.8 | 56   | 250.4 | 53.2 |
| 17   | 16.6 | 03.5 | 77   | 75.3  | 16.0 | 37   | 134.0 | 28.5 | 97   | 192.7 | 41.0 | 57   | 251.3 | 53.5 |
| 18   | 17.6 | 03.7 | 78   | 76.3  | 16.2 | 38   | 135.0 | 28.7 | 98   | 193.6 | 41.2 | 58   | 252.3 | 53.7 |
| 19   | 18.6 | 04.0 | 79   | 77.3  | 16.4 | 39   | 135.9 | 28.9 | 99   | 194.6 | 41.4 | 59   | 253.3 | 53.9 |
| 20   | 19.6 | 04.2 | 80   | 78.2  | 16.6 | 40   | 136.9 | 29.1 | 200  | 195.6 | 41.6 | 60   | 254.3 | 54.1 |
| 21   | 20.5 | 04.4 | 81   | 79.2  | 16.8 | 41   | 137.9 | 29.3 | 201  | 196.6 | 41.8 | 261  | 255.3 | 54.3 |
| 22   | 21.5 | 04.6 | 82   | 80.2  | 17.1 | 42   | 138.9 | 29.5 | 02   | 197.6 | 42.0 | 62   | 256.2 | 54.5 |
| 23   | 22.5 | 04.8 | 83   | 81.2  | 17.3 | 43   | 139.9 | 29.7 | 03   | 198.5 | 42.2 | 63   | 257.2 | 54.7 |
| 24   | 23.5 | 05.0 | 84   | 82.2  | 17.5 | 44   | 140.8 | 30.0 | 04   | 199.5 | 42.4 | 64   | 258.2 | 54.9 |
| 25   | 24.5 | 05.2 | 85   | 83.1  | 17.7 | 45   | 141.8 | 30.2 | 05   | 200.5 | 42.6 | 65   | 259.2 | 55.1 |
| 26   | 25.4 | 05.4 | 86   | 84.1  | 17.9 | 46   | 142.8 | 30.4 | 06   | 201.5 | 42.8 | 66   | 260.1 | 55.3 |
| 27   | 26.4 | 05.6 | 87   | 85.1  | 18.1 | 47   | 143.8 | 30.6 | 07   | 202.4 | 43.1 | 67   | 261.1 | 55.5 |
| 28   | 27.4 | 05.8 | 88   | 86.1  | 18.3 | 48   | 144.7 | 30.8 | 08   | 203.4 | 43.3 | 68   | 262.1 | 55.7 |
| 29   | 28.4 | 06.0 | 89   | 87.0  | 18.5 | 49   | 145.7 | 31.0 | 09   | 204.4 | 43.5 | 69   | 263.1 | 56.0 |
| 30   | 29.3 | 06.2 | 90   | 88.0  | 18.7 | 50   | 146.7 | 31.2 | 10   | 205.4 | 43.7 | 70   | 264.1 | 56.2 |
| 31   | 30.3 | 06.4 | 91   | 89.0  | 18.9 | 51   | 147.7 | 31.4 | 211  | 206.4 | 43.9 | 271  | 265.0 | 56.4 |
| 32   | 31.3 | 06.7 | 92   | 90.0  | 19.1 | 52   | 148.7 | 31.6 | 12   | 207.3 | 44.1 | 72   | 266.0 | 56.6 |
| 33   | 32.3 | 06.9 | 93   | 91.0  | 19.3 | 53   | 149.6 | 31.8 | 13   | 208.3 | 44.3 | 73   | 267.0 | 56.8 |
| 34   | 33.3 | 07.1 | 94   | 91.9  | 19.6 | 54   | 150.6 | 32.0 | 14   | 209.3 | 44.5 | 74   | 268.0 | 57.0 |
| 35   | 34.2 | 07.3 | 95   | 92.9  | 19.8 | 55   | 151.6 | 32.2 | 15   | 210.3 | 44.7 | 75   | 269.0 | 57.2 |
| 36   | 35.2 | 07.5 | 96   | 93.9  | 20.0 | 56   | 152.6 | 32.4 | 16   | 211.2 | 44.9 | 76   | 269.9 | 57.4 |
| 37   | 36.2 | 07.7 | 97   | 94.9  | 20.2 | 57   | 153.5 | 32.7 | 17   | 212.2 | 45.1 | 77   | 270.9 | 57.6 |
| 38   | 37.2 | 07.9 | 98   | 95.8  | 20.4 | 58   | 154.5 | 32.9 | 18   | 213.2 | 45.3 | 78   | 271.9 | 57.8 |
| 39   | 38.1 | 08.1 | 99   | 96.8  | 20.6 | 59   | 155.5 | 33.1 | 19   | 214.2 | 45.6 | 79   | 272.9 | 58.0 |
| 40   | 39.1 | 08.3 | 100  | 97.8  | 20.8 | 60   | 156.5 | 33.3 | 20   | 215.2 | 45.8 | 80   | 273.8 | 58.2 |
| 41   | 40.1 | 08.5 | 101  | 98.8  | 21.0 | 161  | 157.5 | 33.5 | 221  | 216.1 | 46.0 | 281  | 274.8 | 58.4 |
| 42   | 41.1 | 08.7 | 02   | 99.8  | 21.2 | 62   | 158.4 | 33.7 | 22   | 217.1 | 46.2 | 82   | 275.8 | 58.7 |
| 43   | 42.1 | 08.9 | 03   | 100.7 | 21.4 | 63   | 159.4 | 33.9 | 23   | 218.1 | 46.4 | 83   | 276.8 | 58.9 |
| 44   | 43.0 | 09.2 | 04   | 101.7 | 21.6 | 64   | 160.4 | 34.1 | 24   | 219.1 | 46.6 | 84   | 277.8 | 59.1 |
| 45   | 44.0 | 09.4 | 05   | 102.7 | 21.8 | 65   | 161.4 | 34.3 | 25   | 220.1 | 46.8 | 85   | 278.7 | 59.3 |
| 46   | 45.0 | 09.6 | 06   | 103.7 | 22.0 | 66   | 162.3 | 34.5 | 26   | 221.0 | 47.0 | 86   | 279.7 | 59.5 |
| 47   | 46.0 | 09.8 | 07   | 104.6 | 22.3 | 67   | 163.3 | 34.7 | 27   | 222.0 | 47.2 | 87   | 280.7 | 59.7 |
| 48   | 46.9 | 10.0 | 08   | 105.6 | 22.5 | 68   | 164.3 | 34.9 | 28   | 223.0 | 47.4 | 88   | 281.7 | 59.9 |
| 49   | 47.9 | 10.2 | 09   | 106.6 | 22.7 | 69   | 165.3 | 35.2 | 29   | 224.0 | 47.6 | 89   | 282.6 | 60.1 |
| 50   | 48.9 | 10.4 | 10   | 107.6 | 22.9 | 70   | 166.3 | 35.4 | 30   | 225.0 | 47.8 | 90   | 283.6 | 60.3 |
| 51   | 49.9 | 10.6 | 111  | 108.6 | 23.1 | 171  | 167.2 | 35.6 | 231  | 225.9 | 48.0 | 291  | 284.6 | 60.5 |
| 52   | 50.9 | 10.8 | 12   | 109.5 | 23.3 | 72   | 168.2 | 35.8 | 32   | 226.9 | 48.3 | 92   | 285.6 | 60.7 |
| 53   | 51.8 | 11.0 | 13   | 110.5 | 23.5 | 73   | 169.2 | 36.0 | 33   | 227.9 | 48.5 | 93   | 286.6 | 60.9 |
| 54   | 52.8 | 11.2 | 14   | 111.5 | 23.7 | 74   | 170.2 | 36.2 | 34   | 228.9 | 48.7 | 94   | 287.5 | 61.2 |
| 55   | 53.8 | 11.4 | 15   | 112.5 | 23.9 | 75   | 171.2 | 36.4 | 35   | 229.8 | 48.9 | 95   | 288.5 | 61.4 |
| 56   | 54.8 | 11.6 | 16   | 113.4 | 24.1 | 76   | 172.1 | 36.6 | 36   | 230.8 | 49.1 | 96   | 289.5 | 61.6 |
| 57   | 55.7 | 11.9 | 17   | 114.4 | 24.3 | 77   | 173.1 | 36.8 | 37   | 231.8 | 49.3 | 97   | 290.5 | 61.8 |
| 58   | 56.7 | 12.1 | 18   | 115.4 | 24.5 | 78   | 174.1 | 37.0 | 38   | 232.8 | 49.5 | 98   | 291.4 | 62.0 |
| 59   | 57.7 | 12.3 | 19   | 116.4 | 24.8 | 79   | 175.1 | 37.2 | 39   | 233.7 | 49.7 | 99   | 292.4 | 62.2 |
| 60   | 58.7 | 12.5 | 120  | 117.4 | 25.0 | 180  | 176.0 | 37.4 | 240  | 234.7 | 49.9 | 300  | 293.4 | 62.4 |

for 78 Degrees.



TABLE III. Difference of Latitude and Departure for 13 Degrees.

| Diff | Lat. | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.2 | 61   | 59.4  | 13.7 | 121  | 117.9 | 27.2 | 181  | 176.4 | 40.7 | 241  | 234.8 | 54.2 |
| 2    | 01.9 | 00.4 | 62   | 60.4  | 13.9 | 122  | 118.9 | 27.4 | 182  | 177.3 | 40.9 | 242  | 235.8 | 54.4 |
| 3    | 02.9 | 00.7 | 63   | 61.4  | 14.2 | 123  | 119.8 | 27.7 | 183  | 178.3 | 41.2 | 243  | 236.8 | 54.7 |
| 4    | 03.9 | 00.9 | 64   | 62.4  | 14.4 | 124  | 120.8 | 27.9 | 184  | 179.3 | 41.4 | 244  | 237.8 | 54.9 |
| 5    | 04.9 | 01.1 | 65   | 63.3  | 14.6 | 125  | 121.8 | 28.1 | 185  | 180.3 | 41.6 | 245  | 238.7 | 55.1 |
| 6    | 05.8 | 01.3 | 66   | 64.3  | 14.8 | 126  | 122.8 | 28.3 | 186  | 181.2 | 41.8 | 246  | 239.7 | 55.3 |
| 7    | 06.8 | 01.6 | 67   | 65.3  | 15.1 | 127  | 123.7 | 28.6 | 187  | 182.2 | 42.1 | 247  | 240.7 | 55.6 |
| 8    | 07.8 | 01.8 | 68   | 66.3  | 15.3 | 128  | 124.7 | 28.8 | 188  | 183.2 | 42.3 | 248  | 241.6 | 55.8 |
| 9    | 08.8 | 02.0 | 69   | 67.2  | 15.5 | 129  | 125.7 | 29.0 | 189  | 184.2 | 42.5 | 249  | 242.6 | 56.0 |
| 10   | 09.7 | 02.2 | 70   | 68.2  | 15.7 | 130  | 126.7 | 29.2 | 190  | 185.1 | 42.7 | 250  | 243.6 | 56.2 |
| 11   | 10.7 | 02.5 | 71   | 69.2  | 16.0 | 131  | 127.6 | 29.5 | 191  | 186.1 | 43.0 | 251  | 244.6 | 56.5 |
| 12   | 11.7 | 02.7 | 72   | 70.2  | 16.2 | 132  | 128.6 | 29.7 | 192  | 187.1 | 43.2 | 252  | 245.5 | 56.7 |
| 13   | 12.7 | 02.9 | 73   | 71.1  | 16.4 | 133  | 129.6 | 29.9 | 193  | 188.1 | 43.4 | 253  | 246.5 | 56.9 |
| 14   | 13.6 | 03.1 | 74   | 72.1  | 16.6 | 134  | 130.6 | 30.1 | 194  | 189.0 | 43.6 | 254  | 247.5 | 57.1 |
| 15   | 14.6 | 03.4 | 75   | 73.1  | 16.9 | 135  | 131.5 | 30.4 | 195  | 190.0 | 43.9 | 255  | 248.5 | 57.4 |
| 16   | 15.6 | 03.6 | 76   | 74.1  | 17.1 | 136  | 132.5 | 30.6 | 196  | 191.0 | 44.1 | 256  | 249.4 | 57.6 |
| 17   | 16.6 | 03.8 | 77   | 75.0  | 17.3 | 137  | 133.5 | 30.8 | 197  | 192.0 | 44.3 | 257  | 250.4 | 57.8 |
| 18   | 17.5 | 04.0 | 78   | 76.0  | 17.5 | 138  | 134.5 | 31.0 | 198  | 192.9 | 44.5 | 258  | 251.4 | 58.0 |
| 19   | 18.5 | 04.3 | 79   | 77.0  | 17.8 | 139  | 135.4 | 31.3 | 199  | 193.9 | 44.8 | 259  | 252.4 | 58.3 |
| 20   | 19.5 | 04.5 | 80   | 78.0  | 18.0 | 140  | 136.4 | 31.5 | 200  | 194.9 | 45.0 | 260  | 253.3 | 58.5 |
| 21   | 20.5 | 04.7 | 81   | 78.9  | 18.2 | 141  | 137.4 | 31.7 | 201  | 195.9 | 45.2 | 261  | 254.3 | 58.7 |
| 22   | 21.4 | 04.9 | 82   | 79.9  | 18.4 | 142  | 138.4 | 31.9 | 202  | 196.8 | 45.4 | 262  | 255.3 | 58.9 |
| 23   | 22.4 | 05.2 | 83   | 80.9  | 18.7 | 143  | 139.3 | 32.2 | 203  | 197.8 | 45.7 | 263  | 256.3 | 59.2 |
| 24   | 23.4 | 05.4 | 84   | 81.8  | 18.9 | 144  | 140.3 | 32.4 | 204  | 198.8 | 45.9 | 264  | 257.2 | 59.4 |
| 25   | 24.4 | 05.6 | 85   | 82.8  | 19.1 | 145  | 141.3 | 32.6 | 205  | 199.7 | 46.1 | 265  | 258.2 | 59.6 |
| 26   | 25.3 | 05.8 | 86   | 83.8  | 19.3 | 146  | 142.3 | 32.8 | 206  | 200.7 | 46.3 | 266  | 259.2 | 59.8 |
| 27   | 26.3 | 06.1 | 87   | 84.8  | 19.6 | 147  | 143.2 | 33.1 | 207  | 201.7 | 46.6 | 267  | 260.2 | 60.1 |
| 28   | 27.3 | 06.3 | 88   | 85.7  | 19.8 | 148  | 144.2 | 33.3 | 208  | 202.7 | 46.8 | 268  | 261.1 | 60.3 |
| 29   | 28.3 | 06.5 | 89   | 86.7  | 20.0 | 149  | 145.2 | 33.5 | 209  | 203.6 | 47.0 | 269  | 262.1 | 60.5 |
| 30   | 29.2 | 06.7 | 90   | 87.7  | 20.2 | 150  | 146.2 | 33.7 | 210  | 204.6 | 47.2 | 270  | 263.1 | 60.7 |
| 31   | 30.2 | 07.0 | 91   | 88.7  | 20.5 | 151  | 147.1 | 34.0 | 211  | 205.6 | 47.5 | 271  | 264.1 | 61.0 |
| 32   | 31.2 | 07.2 | 92   | 89.6  | 20.7 | 152  | 148.1 | 34.2 | 212  | 206.6 | 47.7 | 272  | 265.0 | 61.2 |
| 33   | 32.2 | 07.4 | 93   | 90.6  | 20.9 | 153  | 149.1 | 34.4 | 213  | 207.5 | 47.9 | 273  | 266.0 | 61.4 |
| 34   | 33.1 | 07.6 | 94   | 91.6  | 21.1 | 154  | 150.1 | 34.6 | 214  | 208.5 | 48.1 | 274  | 267.0 | 61.6 |
| 35   | 34.1 | 07.9 | 95   | 92.6  | 21.4 | 155  | 151.0 | 34.9 | 215  | 209.5 | 48.4 | 275  | 268.0 | 61.9 |
| 36   | 35.1 | 08.1 | 96   | 93.5  | 21.6 | 156  | 152.0 | 35.1 | 216  | 210.5 | 48.6 | 276  | 268.9 | 62.1 |
| 37   | 36.1 | 08.3 | 97   | 94.5  | 21.8 | 157  | 153.0 | 35.3 | 217  | 211.4 | 48.8 | 277  | 269.9 | 62.3 |
| 38   | 37.0 | 08.5 | 98   | 95.5  | 22.0 | 158  | 154.0 | 35.5 | 218  | 212.4 | 49.0 | 278  | 270.9 | 62.5 |
| 39   | 38.0 | 08.8 | 99   | 96.5  | 22.3 | 159  | 154.9 | 35.8 | 219  | 213.4 | 49.3 | 279  | 271.9 | 62.8 |
| 40   | 39.0 | 08.0 | 100  | 97.4  | 22.5 | 160  | 155.9 | 36.0 | 220  | 214.4 | 49.5 | 280  | 272.8 | 63.0 |
| 41   | 39.9 | 09.2 | 101  | 98.4  | 22.7 | 161  | 156.9 | 36.2 | 221  | 215.3 | 49.7 | 281  | 273.8 | 63.2 |
| 42   | 40.9 | 09.4 | 102  | 99.4  | 22.9 | 162  | 157.9 | 36.4 | 222  | 216.3 | 49.9 | 282  | 274.8 | 63.4 |
| 43   | 41.9 | 09.7 | 103  | 100.4 | 23.2 | 163  | 158.8 | 36.7 | 223  | 217.3 | 50.2 | 283  | 275.8 | 63.7 |
| 44   | 42.9 | 09.9 | 104  | 101.3 | 23.4 | 164  | 159.8 | 36.9 | 224  | 218.3 | 50.4 | 284  | 276.7 | 63.9 |
| 45   | 43.8 | 10.1 | 105  | 102.3 | 23.6 | 165  | 160.8 | 37.1 | 225  | 219.2 | 50.6 | 285  | 277.7 | 64.1 |
| 46   | 44.8 | 10.3 | 106  | 103.3 | 23.8 | 166  | 161.7 | 37.3 | 226  | 220.2 | 50.8 | 286  | 278.7 | 64.3 |
| 47   | 45.8 | 10.6 | 107  | 104.3 | 24.1 | 167  | 162.7 | 37.6 | 227  | 221.2 | 51.1 | 287  | 279.6 | 64.6 |
| 48   | 46.8 | 10.8 | 108  | 105.2 | 24.3 | 168  | 163.7 | 37.8 | 228  | 222.2 | 51.3 | 288  | 280.6 | 64.8 |
| 49   | 47.7 | 11.0 | 109  | 106.2 | 24.5 | 169  | 164.7 | 38.0 | 229  | 223.1 | 51.5 | 289  | 281.6 | 65.0 |
| 50   | 48.7 | 11.2 | 110  | 107.2 | 24.7 | 170  | 165.6 | 38.2 | 230  | 224.1 | 51.7 | 290  | 282.6 | 65.2 |
| 51   | 49.7 | 11.5 | 111  | 108.2 | 25.0 | 171  | 166.6 | 38.5 | 231  | 225.1 | 52.0 | 291  | 283.5 | 65.5 |
| 52   | 50.7 | 11.7 | 112  | 109.1 | 25.2 | 172  | 167.6 | 38.7 | 232  | 226.1 | 52.2 | 292  | 284.5 | 65.7 |
| 53   | 51.6 | 11.9 | 113  | 110.1 | 25.4 | 173  | 168.6 | 38.9 | 233  | 227.0 | 52.4 | 293  | 285.5 | 65.9 |
| 54   | 52.6 | 12.1 | 114  | 111.1 | 25.6 | 174  | 169.5 | 39.1 | 234  | 228.0 | 52.6 | 294  | 286.5 | 66.1 |
| 55   | 53.6 | 12.4 | 115  | 112.1 | 25.9 | 175  | 170.5 | 39.4 | 235  | 229.0 | 52.9 | 295  | 287.4 | 66.4 |
| 56   | 54.6 | 12.6 | 116  | 113.0 | 26.1 | 176  | 171.5 | 39.6 | 236  | 230.0 | 53.1 | 296  | 288.4 | 66.6 |
| 57   | 55.5 | 12.8 | 117  | 114.0 | 26.3 | 177  | 172.5 | 39.8 | 237  | 230.9 | 53.3 | 297  | 289.4 | 66.8 |
| 58   | 56.5 | 13.0 | 118  | 115.0 | 26.5 | 178  | 173.4 | 40.0 | 238  | 231.9 | 53.5 | 298  | 290.4 | 67.0 |
| 59   | 57.5 | 13.3 | 119  | 116.0 | 26.8 | 179  | 174.4 | 40.2 | 239  | 232.9 | 53.8 | 299  | 291.3 | 67.3 |
| 60   | 58.5 | 13.5 | 120  | 116.9 | 27.0 | 180  | 175.4 | 40.5 | 240  | 233.9 | 54.0 | 300  | 292.3 | 67.5 |

TABLE III. Difference of Latitude and Departure for 14 Degrees.

| Dist | Lat. | Dep. | Dist | Lat.  | Dep. | Dist | Lat.  | Dep. | Dist | Lat.  | Dep. | Dist | Lat.  | Dep. | Dist | Lat.  | Dep. |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.2 | 61   | 59.2  | 14.8 | 121  | 117.4 | 29.3 | 181  | 175.6 | 43.8 | 241  | 233.8 | 58.3 | 301  | 292.0 | 72.8 |
| 2    | 01.9 | 00.5 | 62   | 60.2  | 15.0 | 122  | 118.4 | 29.5 | 182  | 176.6 | 44.0 | 242  | 234.8 | 58.6 | 302  | 293.0 | 73.1 |
| 3    | 02.9 | 00.7 | 63   | 61.1  | 15.2 | 123  | 119.3 | 29.8 | 183  | 177.6 | 44.3 | 243  | 235.8 | 58.9 | 303  | 294.0 | 73.4 |
| 4    | 03.9 | 01.0 | 64   | 62.1  | 15.5 | 124  | 120.3 | 30.0 | 184  | 178.5 | 44.5 | 244  | 236.7 | 59.2 | 304  | 295.0 | 73.7 |
| 5    | 04.9 | 01.2 | 65   | 63.1  | 15.7 | 125  | 121.3 | 30.2 | 185  | 179.5 | 44.8 | 245  | 237.7 | 59.5 | 305  | 296.0 | 74.0 |
| 6    | 05.8 | 01.5 | 66   | 64.0  | 16.0 | 126  | 122.3 | 30.5 | 186  | 180.5 | 45.0 | 246  | 238.7 | 59.8 | 306  | 297.0 | 74.3 |
| 7    | 06.8 | 01.7 | 67   | 65.0  | 16.2 | 127  | 123.2 | 30.7 | 187  | 181.4 | 45.3 | 247  | 239.7 | 60.1 | 307  | 298.0 | 74.6 |
| 8    | 07.8 | 01.9 | 68   | 66.0  | 16.5 | 128  | 124.2 | 31.0 | 188  | 182.4 | 45.5 | 248  | 240.7 | 60.4 | 308  | 299.0 | 74.9 |
| 9    | 08.7 | 02.2 | 69   | 66.9  | 16.7 | 129  | 125.2 | 31.2 | 189  | 183.4 | 45.7 | 249  | 241.7 | 60.7 | 309  | 300.0 | 75.2 |
| 10   | 09.7 | 02.4 | 70   | 67.9  | 16.9 | 130  | 126.1 | 31.5 | 190  | 184.4 | 46.0 | 250  | 242.6 | 61.0 | 310  | 301.0 | 75.5 |
| 11   | 10.7 | 02.7 | 71   | 68.9  | 17.2 | 131  | 127.1 | 31.7 | 191  | 185.3 | 46.2 | 251  | 243.5 | 61.3 | 311  | 302.0 | 75.8 |
| 12   | 11.6 | 02.9 | 72   | 69.9  | 17.4 | 132  | 128.1 | 31.9 | 192  | 186.3 | 46.5 | 252  | 244.5 | 61.6 | 312  | 303.0 | 76.1 |
| 13   | 12.6 | 03.1 | 73   | 70.8  | 17.7 | 133  | 129.0 | 32.2 | 193  | 187.3 | 46.7 | 253  | 245.5 | 61.9 | 313  | 304.0 | 76.4 |
| 14   | 13.6 | 03.4 | 74   | 71.8  | 17.9 | 134  | 130.0 | 32.4 | 194  | 188.2 | 46.9 | 254  | 246.4 | 62.2 | 314  | 305.0 | 76.7 |
| 15   | 14.6 | 03.6 | 75   | 72.8  | 18.1 | 135  | 131.0 | 32.7 | 195  | 189.2 | 47.2 | 255  | 247.4 | 62.5 | 315  | 306.0 | 77.0 |
| 16   | 15.5 | 03.9 | 76   | 73.7  | 18.4 | 136  | 132.0 | 32.9 | 196  | 190.2 | 47.4 | 256  | 248.4 | 62.8 | 316  | 307.0 | 77.3 |
| 17   | 16.5 | 04.1 | 77   | 74.7  | 18.6 | 137  | 132.9 | 33.2 | 197  | 191.1 | 47.7 | 257  | 249.4 | 63.1 | 317  | 308.0 | 77.6 |
| 18   | 17.5 | 04.4 | 78   | 75.7  | 18.9 | 138  | 133.9 | 33.4 | 198  | 192.1 | 47.9 | 258  | 250.4 | 63.4 | 318  | 309.0 | 77.9 |
| 19   | 18.4 | 04.6 | 79   | 76.7  | 19.1 | 139  | 134.9 | 33.6 | 199  | 193.1 | 48.2 | 259  | 251.4 | 63.7 | 319  | 310.0 | 78.2 |
| 20   | 19.4 | 04.8 | 80   | 77.6  | 19.4 | 140  | 135.8 | 33.9 | 200  | 194.1 | 48.4 | 260  | 252.3 | 64.0 | 320  | 311.0 | 78.5 |
| 21   | 20.4 | 05.1 | 81   | 78.6  | 19.6 | 141  | 136.8 | 34.1 | 201  | 195.0 | 48.6 | 261  | 253.2 | 64.3 | 321  | 312.0 | 78.8 |
| 22   | 21.3 | 05.3 | 82   | 79.6  | 19.8 | 142  | 137.8 | 34.4 | 202  | 196.0 | 48.9 | 262  | 254.2 | 64.6 | 322  | 313.0 | 79.1 |
| 23   | 22.3 | 05.6 | 83   | 80.5  | 20.1 | 143  | 138.7 | 34.6 | 203  | 197.0 | 49.1 | 263  | 255.2 | 64.9 | 323  | 314.0 | 79.4 |
| 24   | 23.3 | 05.8 | 84   | 81.5  | 20.3 | 144  | 139.7 | 34.8 | 204  | 197.9 | 49.4 | 264  | 256.2 | 65.2 | 324  | 315.0 | 79.7 |
| 25   | 24.3 | 06.0 | 85   | 82.5  | 20.6 | 145  | 140.7 | 35.1 | 205  | 198.9 | 49.6 | 265  | 257.1 | 65.5 | 325  | 316.0 | 80.0 |
| 26   | 25.2 | 06.3 | 86   | 83.4  | 20.8 | 146  | 141.7 | 35.3 | 206  | 199.9 | 49.9 | 266  | 258.1 | 65.8 | 326  | 317.0 | 80.3 |
| 27   | 26.2 | 06.5 | 87   | 84.4  | 21.1 | 147  | 142.6 | 35.6 | 207  | 200.8 | 50.1 | 267  | 259.1 | 66.1 | 327  | 318.0 | 80.6 |
| 28   | 27.2 | 06.8 | 88   | 85.4  | 21.3 | 148  | 143.6 | 35.8 | 208  | 201.8 | 50.3 | 268  | 260.0 | 66.4 | 328  | 319.0 | 80.9 |
| 29   | 28.1 | 07.0 | 89   | 86.4  | 21.5 | 149  | 144.6 | 36.1 | 209  | 202.8 | 50.6 | 269  | 261.0 | 66.7 | 329  | 320.0 | 81.2 |
| 30   | 29.1 | 07.3 | 90   | 87.3  | 21.8 | 150  | 145.5 | 36.3 | 210  | 203.8 | 50.8 | 270  | 262.0 | 67.0 | 330  | 321.0 | 81.5 |
| 31   | 30.1 | 07.5 | 91   | 88.3  | 22.0 | 151  | 146.5 | 36.5 | 211  | 204.7 | 51.1 | 271  | 262.9 | 67.3 | 331  | 322.0 | 81.8 |
| 32   | 31.0 | 07.7 | 92   | 89.3  | 22.3 | 152  | 147.5 | 36.8 | 212  | 205.7 | 51.3 | 272  | 263.9 | 67.6 | 332  | 323.0 | 82.1 |
| 33   | 32.0 | 08.0 | 93   | 90.2  | 22.5 | 153  | 148.5 | 37.0 | 213  | 206.7 | 51.5 | 273  | 264.9 | 67.9 | 333  | 324.0 | 82.4 |
| 34   | 33.0 | 08.2 | 94   | 91.2  | 22.7 | 154  | 149.4 | 37.3 | 214  | 207.6 | 51.8 | 274  | 265.9 | 68.2 | 334  | 325.0 | 82.7 |
| 35   | 34.0 | 08.5 | 95   | 92.2  | 23.0 | 155  | 150.4 | 37.5 | 215  | 208.6 | 52.0 | 275  | 266.8 | 68.5 | 335  | 326.0 | 83.0 |
| 36   | 34.9 | 08.7 | 96   | 93.1  | 23.2 | 156  | 151.4 | 37.7 | 216  | 209.6 | 52.3 | 276  | 267.8 | 68.8 | 336  | 327.0 | 83.3 |
| 37   | 35.9 | 09.0 | 97   | 94.1  | 23.5 | 157  | 152.3 | 38.0 | 217  | 210.5 | 52.5 | 277  | 268.8 | 69.1 | 337  | 328.0 | 83.6 |
| 38   | 36.9 | 09.2 | 98   | 95.1  | 23.7 | 158  | 153.3 | 38.2 | 218  | 211.5 | 52.8 | 278  | 269.7 | 69.4 | 338  | 329.0 | 83.9 |
| 39   | 37.8 | 09.4 | 99   | 96.1  | 24.0 | 159  | 154.3 | 38.5 | 219  | 212.5 | 53.0 | 279  | 270.7 | 69.7 | 339  | 330.0 | 84.2 |
| 40   | 38.8 | 09.7 | 100  | 97.0  | 24.2 | 160  | 155.2 | 38.7 | 220  | 213.5 | 53.2 | 280  | 271.7 | 70.0 | 340  | 331.0 | 84.5 |
| 41   | 39.8 | 09.9 | 101  | 98.0  | 24.4 | 161  | 156.2 | 39.0 | 221  | 214.4 | 53.5 | 281  | 272.6 | 70.3 | 341  | 332.0 | 84.8 |
| 42   | 40.8 | 10.2 | 102  | 99.0  | 24.7 | 162  | 157.2 | 39.2 | 222  | 215.4 | 53.7 | 282  | 273.6 | 70.6 | 342  | 333.0 | 85.1 |
| 43   | 41.7 | 10.4 | 103  | 99.9  | 24.9 | 163  | 158.2 | 39.4 | 223  | 216.4 | 54.0 | 283  | 274.6 | 70.9 | 343  | 334.0 | 85.4 |
| 44   | 42.7 | 10.6 | 104  | 100.9 | 25.2 | 164  | 159.1 | 39.7 | 224  | 217.3 | 54.2 | 284  | 275.6 | 71.2 | 344  | 335.0 | 85.7 |
| 45   | 43.7 | 10.9 | 105  | 101.9 | 25.4 | 165  | 160.1 | 39.9 | 225  | 218.3 | 54.4 | 285  | 276.6 | 71.5 | 345  | 336.0 | 86.0 |
| 46   | 44.6 | 11.1 | 106  | 102.8 | 25.7 | 166  | 161.1 | 40.2 | 226  | 219.3 | 54.7 | 286  | 277.6 | 71.8 | 346  | 337.0 | 86.3 |
| 47   | 45.6 | 11.4 | 107  | 103.8 | 25.9 | 167  | 162.0 | 40.4 | 227  | 220.3 | 54.9 | 287  | 278.6 | 72.1 | 347  | 338.0 | 86.6 |
| 48   | 46.6 | 11.6 | 108  | 104.8 | 26.1 | 168  | 163.0 | 40.7 | 228  | 221.2 | 55.2 | 288  | 279.6 | 72.4 | 348  | 339.0 | 86.9 |
| 49   | 47.5 | 11.9 | 109  | 105.8 | 26.4 | 169  | 164.0 | 40.9 | 229  | 222.2 | 55.4 | 289  | 280.6 | 72.7 | 349  | 340.0 | 87.2 |
| 50   | 48.5 | 12.1 | 110  | 106.7 | 26.6 | 170  | 164.9 | 41.1 | 230  | 223.2 | 55.7 | 290  | 281.6 | 73.0 | 350  | 341.0 | 87.5 |
| 51   | 49.5 | 12.3 | 111  | 107.7 | 26.9 | 171  | 165.9 | 41.4 | 231  | 224.1 | 55.9 | 291  | 282.6 | 73.3 | 351  | 342.0 | 87.8 |
| 52   | 50.5 | 12.6 | 112  | 108.7 | 27.1 | 172  | 166.9 | 41.6 | 232  | 225.1 | 56.1 | 292  | 283.6 | 73.6 | 352  | 343.0 | 88.1 |
| 53   | 51.4 | 12.8 | 113  | 109.6 | 27.3 | 173  | 167.9 | 41.9 | 233  | 226.1 | 56.4 | 293  | 284.6 | 73.9 | 353  | 344.0 | 88.4 |
| 54   | 52.4 | 13.1 | 114  | 110.6 | 27.6 | 174  | 168.8 | 42.1 | 234  | 227.0 | 56.6 | 294  | 285.6 | 74.2 | 354  | 345.0 | 88.7 |
| 55   | 53.4 | 13.3 | 115  | 111.6 | 27.8 | 175  | 169.8 | 42.3 | 235  | 228.0 | 56.9 | 295  | 286.6 | 74.5 | 355  | 346.0 | 89.0 |
| 56   | 54.3 | 13.6 | 116  | 112.6 | 28.1 | 176  | 170.8 | 42.6 | 236  | 229.0 | 57.1 | 296  | 287.6 | 74.8 | 356  | 347.0 | 89.3 |
| 57   | 55.3 | 13.8 | 117  | 113.5 | 28.3 | 177  | 171.7 | 42.8 | 237  | 230.0 | 57.4 | 297  | 288.6 | 75.1 | 357  | 348.0 | 89.6 |
| 58   | 56.3 | 14.0 | 118  | 114.5 | 28.6 | 178  | 172.7 | 43.1 | 238  | 230.9 | 57.6 | 298  | 289.6 | 75.4 | 358  | 349.0 | 89.9 |
| 59   | 57.2 | 14.3 | 119  | 115.5 | 28.8 | 179  | 173.7 | 43.3 | 239  | 231.9 | 57.8 | 299  | 290.6 | 75.7 | 359  | 350.0 | 90.2 |
| 60   | 58.2 | 14.5 | 120  | 116.4 | 29.0 | 180  | 174.6 | 43.6 | 240  | 232.9 | 58.1 | 300  | 291.6 | 76.0 | 360  | 351.0 | 90.5 |
| Dist | Dep. | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat. |

for 76 Degrees.

TABLE III. Difference of Latitude and Departure for 15 Degrees.

| Diff | Lat. | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.3 | 61   | 58.9  | 15.8 | 121  | 116.9 | 31.3 | 181  | 174.8 | 46.8 | 241  | 232.8 | 62.4 |
| 2    | 01.9 | 00.5 | 62   | 59.9  | 16.0 | 22   | 117.8 | 31.6 | 82   | 175.8 | 47.1 | 42   | 233.7 | 62.6 |
| 3    | 02.9 | 00.8 | 63   | 60.9  | 16.3 | 23   | 118.8 | 31.8 | 83   | 176.8 | 47.4 | 43   | 234.7 | 62.9 |
| 4    | 03.9 | 01.0 | 64   | 61.8  | 16.6 | 24   | 119.8 | 32.1 | 84   | 177.7 | 47.6 | 44   | 235.7 | 63.1 |
| 5    | 04.8 | 01.3 | 65   | 62.8  | 16.8 | 25   | 120.7 | 32.4 | 85   | 178.7 | 47.9 | 45   | 236.6 | 63.4 |
| 6    | 05.8 | 01.6 | 66   | 63.7  | 17.1 | 26   | 121.7 | 32.6 | 86   | 179.7 | 48.1 | 46   | 237.6 | 63.7 |
| 7    | 06.8 | 01.8 | 67   | 64.7  | 17.3 | 27   | 122.7 | 32.9 | 87   | 180.6 | 48.4 | 47   | 238.6 | 63.9 |
| 8    | 07.7 | 02.1 | 68   | 65.7  | 17.6 | 28   | 123.6 | 33.1 | 88   | 181.6 | 48.7 | 48   | 239.5 | 64.2 |
| 9    | 08.7 | 02.3 | 69   | 66.6  | 17.9 | 29   | 124.6 | 33.4 | 89   | 182.6 | 48.9 | 49   | 240.5 | 64.4 |
| 10   | 09.7 | 02.6 | 70   | 67.6  | 18.1 | 30   | 125.6 | 33.6 | 90   | 183.5 | 49.2 | 50   | 241.5 | 64.7 |
| 11   | 10.6 | 02.8 | 71   | 68.6  | 18.4 | 131  | 126.5 | 33.9 | 191  | 184.5 | 49.4 | 251  | 242.4 | 65.0 |
| 12   | 11.6 | 03.1 | 72   | 69.5  | 18.6 | 32   | 127.5 | 34.2 | 92   | 185.5 | 49.7 | 52   | 243.4 | 65.2 |
| 13   | 12.6 | 03.4 | 73   | 70.5  | 18.9 | 33   | 128.5 | 34.4 | 93   | 186.4 | 49.9 | 53   | 244.4 | 65.5 |
| 14   | 13.5 | 03.6 | 74   | 71.5  | 19.2 | 34   | 129.4 | 34.7 | 94   | 187.4 | 50.2 | 54   | 245.3 | 65.7 |
| 15   | 14.5 | 03.9 | 75   | 72.4  | 19.4 | 35   | 130.4 | 34.9 | 95   | 188.4 | 50.5 | 55   | 246.3 | 66.0 |
| 16   | 15.5 | 04.1 | 76   | 73.4  | 19.7 | 36   | 131.4 | 35.2 | 96   | 189.3 | 50.7 | 56   | 247.3 | 66.3 |
| 17   | 16.4 | 04.4 | 77   | 74.4  | 19.9 | 37   | 132.3 | 35.5 | 97   | 190.3 | 51.0 | 57   | 248.2 | 66.5 |
| 18   | 17.4 | 04.7 | 78   | 75.3  | 20.2 | 38   | 133.3 | 35.7 | 98   | 191.2 | 51.2 | 58   | 249.2 | 66.8 |
| 19   | 18.4 | 04.9 | 79   | 76.3  | 20.4 | 39   | 134.3 | 36.0 | 99   | 192.2 | 51.5 | 59   | 250.2 | 67.0 |
| 20   | 19.3 | 05.1 | 80   | 77.3  | 20.7 | 40   | 135.2 | 36.2 | 200  | 193.2 | 51.8 | 60   | 251.1 | 67.3 |
| 21   | 20.3 | 05.4 | 81   | 78.2  | 21.0 | 141  | 136.2 | 36.5 | 201  | 194.1 | 52.0 | 61   | 252.1 | 67.5 |
| 22   | 21.2 | 05.7 | 82   | 79.2  | 21.2 | 42   | 137.2 | 36.7 | 02   | 195.1 | 52.3 | 62   | 253.1 | 67.8 |
| 23   | 22.2 | 06.0 | 83   | 80.2  | 21.5 | 43   | 138.1 | 37.0 | 03   | 196.1 | 52.5 | 63   | 254.0 | 68.1 |
| 24   | 23.2 | 06.2 | 84   | 81.1  | 21.7 | 44   | 139.1 | 37.3 | 04   | 197.0 | 52.8 | 64   | 255.0 | 68.3 |
| 25   | 24.1 | 06.5 | 85   | 82.1  | 22.0 | 45   | 140.1 | 37.5 | 05   | 198.0 | 53.1 | 65   | 256.0 | 68.6 |
| 26   | 25.1 | 06.7 | 86   | 83.1  | 22.3 | 46   | 141.0 | 37.8 | 06   | 199.0 | 53.3 | 66   | 256.9 | 68.8 |
| 27   | 26.1 | 07.0 | 87   | 84.0  | 22.5 | 47   | 142.0 | 38.0 | 07   | 199.9 | 53.6 | 67   | 257.9 | 69.1 |
| 28   | 27.0 | 07.2 | 88   | 85.0  | 22.8 | 48   | 143.0 | 38.3 | 08   | 200.9 | 53.8 | 68   | 258.9 | 69.4 |
| 29   | 28.0 | 07.5 | 89   | 86.0  | 23.0 | 49   | 143.9 | 38.6 | 09   | 201.9 | 54.1 | 69   | 259.8 | 69.6 |
| 30   | 29.0 | 07.8 | 90   | 86.9  | 23.3 | 50   | 144.9 | 38.8 | 10   | 202.8 | 54.3 | 70   | 260.8 | 69.9 |
| 31   | 29.9 | 08.0 | 91   | 87.9  | 23.6 | 151  | 145.8 | 39.1 | 211  | 203.8 | 54.6 | 271  | 261.8 | 70.1 |
| 32   | 30.9 | 08.3 | 92   | 88.9  | 23.8 | 52   | 146.8 | 39.3 | 12   | 204.8 | 54.9 | 72   | 262.7 | 70.4 |
| 33   | 31.9 | 08.5 | 93   | 89.8  | 24.1 | 53   | 147.8 | 39.6 | 13   | 205.7 | 55.1 | 73   | 263.7 | 70.7 |
| 34   | 32.8 | 08.8 | 94   | 90.8  | 24.3 | 54   | 148.7 | 39.9 | 14   | 206.7 | 55.4 | 74   | 264.7 | 70.9 |
| 35   | 33.8 | 09.1 | 95   | 91.8  | 24.6 | 55   | 149.7 | 40.1 | 15   | 207.7 | 55.6 | 75   | 265.6 | 71.2 |
| 36   | 34.8 | 09.3 | 96   | 92.7  | 24.8 | 56   | 150.7 | 40.4 | 16   | 208.6 | 55.9 | 76   | 266.6 | 71.4 |
| 37   | 35.7 | 09.6 | 97   | 93.7  | 25.1 | 57   | 151.6 | 40.6 | 17   | 209.6 | 56.1 | 77   | 267.6 | 71.7 |
| 38   | 36.7 | 09.8 | 98   | 94.7  | 25.4 | 58   | 152.6 | 40.9 | 18   | 210.6 | 56.4 | 78   | 268.5 | 71.9 |
| 39   | 37.7 | 10.1 | 99   | 95.6  | 25.6 | 59   | 153.6 | 41.1 | 19   | 211.5 | 56.7 | 79   | 269.5 | 72.2 |
| 40   | 38.6 | 10.4 | 100  | 96.6  | 25.9 | 60   | 154.5 | 41.4 | 20   | 212.5 | 56.9 | 80   | 270.5 | 72.5 |
| 41   | 39.6 | 10.6 | 101  | 97.6  | 26.1 | 161  | 155.5 | 41.7 | 221  | 213.5 | 57.2 | 281  | 271.4 | 72.7 |
| 42   | 40.6 | 10.9 | 02   | 98.5  | 26.4 | 62   | 156.5 | 41.9 | 22   | 214.4 | 57.5 | 82   | 272.4 | 73.0 |
| 43   | 41.5 | 11.1 | 03   | 99.5  | 26.7 | 63   | 157.4 | 42.2 | 23   | 215.4 | 57.7 | 83   | 273.4 | 73.2 |
| 44   | 42.5 | 11.4 | 04   | 100.5 | 26.9 | 64   | 158.4 | 42.4 | 24   | 216.4 | 58.0 | 84   | 274.3 | 73.5 |
| 45   | 43.5 | 11.6 | 05   | 101.4 | 27.2 | 65   | 159.4 | 42.7 | 25   | 217.3 | 58.2 | 85   | 275.3 | 73.8 |
| 46   | 44.4 | 11.9 | 06   | 102.4 | 27.4 | 66   | 160.3 | 43.0 | 26   | 218.3 | 58.5 | 86   | 276.2 | 74.0 |
| 47   | 45.4 | 12.2 | 07   | 103.4 | 27.7 | 67   | 161.3 | 43.2 | 27   | 219.3 | 58.7 | 87   | 277.2 | 74.3 |
| 48   | 46.4 | 12.4 | 08   | 104.3 | 28.0 | 68   | 162.3 | 43.5 | 28   | 220.2 | 59.0 | 88   | 278.2 | 74.5 |
| 49   | 47.3 | 12.7 | 09   | 105.3 | 28.2 | 69   | 163.2 | 43.7 | 29   | 221.2 | 59.3 | 89   | 279.1 | 74.8 |
| 50   | 48.3 | 12.9 | 10   | 106.2 | 28.5 | 70   | 164.2 | 44.0 | 30   | 222.2 | 59.5 | 90   | 280.1 | 75.0 |
| 51   | 49.3 | 13.2 | 111  | 107.2 | 28.7 | 171  | 165.2 | 44.3 | 231  | 223.1 | 59.8 | 291  | 281.1 | 75.3 |
| 52   | 50.2 | 13.5 | 12   | 108.2 | 29.0 | 72   | 166.1 | 44.5 | 32   | 224.1 | 60.0 | 92   | 282.0 | 75.6 |
| 53   | 51.2 | 13.7 | 13   | 109.1 | 29.2 | 73   | 167.1 | 44.8 | 33   | 225.1 | 60.3 | 93   | 283.0 | 75.8 |
| 54   | 52.2 | 14.0 | 14   | 110.1 | 29.5 | 74   | 168.1 | 45.0 | 34   | 226.0 | 60.6 | 94   | 284.0 | 76.1 |
| 55   | 53.1 | 14.2 | 15   | 111.1 | 29.8 | 75   | 169.0 | 45.3 | 35   | 227.0 | 60.8 | 95   | 284.9 | 76.3 |
| 56   | 54.1 | 14.5 | 16   | 112.0 | 30.0 | 76   | 170.0 | 45.5 | 36   | 228.0 | 61.1 | 96   | 285.9 | 76.6 |
| 57   | 55.1 | 14.8 | 17   | 113.0 | 30.3 | 77   | 171.0 | 45.8 | 37   | 228.9 | 61.3 | 97   | 286.9 | 76.9 |
| 58   | 56.0 | 15.0 | 18   | 114.0 | 30.5 | 78   | 171.9 | 46.1 | 38   | 229.9 | 61.6 | 98   | 287.8 | 77.1 |
| 59   | 57.0 | 15.3 | 19   | 114.9 | 30.8 | 79   | 172.9 | 46.3 | 39   | 230.9 | 61.9 | 99   | 288.8 | 77.4 |
| 60   | 58.0 | 15.5 | 120  | 115.9 | 31.1 | 180  | 173.9 | 46.6 | 240  | 231.8 | 62.1 | 300  | 289.8 | 77.6 |

for 75 Degrees.



TABLE III. Difference of Latitude and Departure for 16 Degrees.

| Dist | Lat  | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.3 | 61   | 58.6  | 16.8 | 121  | 116.3 | 33.3 | 181  | 174.0 | 49.9 | 241  | 231.6 | 66.4 |
| 2    | 01.9 | 00.6 | 62   | 59.6  | 17.1 | 122  | 117.3 | 33.6 | 82   | 174.9 | 50.2 | 42   | 232.6 | 66.7 |
| 3    | 02.9 | 00.8 | 63   | 60.6  | 17.4 | 23   | 118.2 | 33.9 | 83   | 175.9 | 50.4 | 43   | 233.6 | 67.0 |
| 4    | 03.8 | 01.1 | 64   | 61.5  | 17.6 | 24   | 119.2 | 34.2 | 84   | 176.8 | 50.7 | 44   | 234.5 | 67.2 |
| 5    | 04.8 | 01.4 | 65   | 62.5  | 17.9 | 25   | 120.1 | 34.4 | 85   | 177.8 | 51.0 | 45   | 235.5 | 67.5 |
| 6    | 05.8 | 01.7 | 66   | 63.4  | 18.2 | 26   | 121.1 | 34.7 | 86   | 178.8 | 51.3 | 46   | 236.4 | 67.8 |
| 7    | 06.7 | 01.9 | 67   | 64.4  | 18.5 | 27   | 122.1 | 35.0 | 87   | 179.7 | 51.5 | 47   | 237.4 | 68.1 |
| 8    | 07.7 | 02.2 | 68   | 65.4  | 18.7 | 28   | 123.0 | 35.3 | 88   | 180.7 | 51.8 | 48   | 238.4 | 68.3 |
| 9    | 08.7 | 02.5 | 69   | 66.3  | 19.0 | 29   | 124.0 | 35.6 | 89   | 181.7 | 52.1 | 49   | 239.3 | 68.6 |
| 10   | 09.6 | 02.8 | 70   | 67.3  | 19.3 | 30   | 124.9 | 35.8 | 90   | 182.6 | 52.4 | 50   | 240.3 | 68.9 |
| 11   | 10.6 | 03.0 | 71   | 68.2  | 19.6 | 131  | 125.9 | 36.1 | 191  | 183.6 | 52.6 | 251  | 241.2 | 69.2 |
| 12   | 11.5 | 03.3 | 72   | 69.2  | 19.8 | 32   | 126.9 | 36.4 | 92   | 184.5 | 52.9 | 52   | 242.2 | 69.5 |
| 13   | 12.5 | 03.6 | 73   | 70.2  | 20.1 | 33   | 127.8 | 36.7 | 93   | 185.5 | 53.2 | 53   | 243.2 | 69.7 |
| 14   | 13.5 | 03.9 | 74   | 71.1  | 20.4 | 34   | 128.8 | 36.9 | 94   | 186.5 | 53.5 | 54   | 244.1 | 70.0 |
| 15   | 14.4 | 04.1 | 75   | 72.1  | 20.7 | 35   | 129.8 | 37.2 | 95   | 187.4 | 53.7 | 55   | 245.1 | 70.3 |
| 16   | 15.4 | 04.4 | 76   | 73.0  | 20.9 | 36   | 130.7 | 37.5 | 96   | 188.4 | 54.0 | 56   | 246.0 | 70.6 |
| 17   | 16.3 | 04.7 | 77   | 74.0  | 21.2 | 37   | 131.7 | 37.8 | 97   | 189.3 | 54.3 | 57   | 247.0 | 70.8 |
| 18   | 17.3 | 05.0 | 78   | 75.0  | 21.5 | 38   | 132.6 | 38.0 | 98   | 190.3 | 54.6 | 58   | 248.0 | 71.1 |
| 19   | 18.3 | 05.2 | 79   | 75.9  | 21.8 | 39   | 133.6 | 38.3 | 99   | 191.3 | 54.8 | 59   | 248.9 | 71.4 |
| 20   | 19.2 | 05.5 | 80   | 76.9  | 22.0 | 40   | 134.6 | 38.6 | 200  | 192.2 | 55.1 | 60   | 249.9 | 71.7 |
| 21   | 20.2 | 05.8 | 81   | 77.9  | 22.3 | 141  | 135.5 | 38.9 | 201  | 193.2 | 55.4 | 261  | 250.9 | 71.9 |
| 22   | 21.1 | 06.1 | 82   | 78.8  | 22.6 | 42   | 136.5 | 39.1 | 02   | 194.1 | 55.7 | 62   | 251.8 | 72.2 |
| 23   | 22.1 | 06.3 | 83   | 79.8  | 22.9 | 43   | 137.4 | 39.4 | 03   | 195.1 | 55.9 | 63   | 252.8 | 72.5 |
| 24   | 23.1 | 06.6 | 84   | 80.7  | 23.1 | 44   | 138.4 | 39.7 | 04   | 196.1 | 56.2 | 64   | 253.7 | 72.8 |
| 25   | 24.0 | 06.9 | 85   | 81.7  | 23.4 | 45   | 139.4 | 40.0 | 05   | 197.0 | 56.5 | 65   | 254.7 | 73.1 |
| 26   | 25.0 | 07.2 | 86   | 82.7  | 23.7 | 46   | 140.3 | 40.2 | 06   | 198.0 | 56.8 | 66   | 255.7 | 73.4 |
| 27   | 26.0 | 07.4 | 87   | 83.6  | 24.0 | 47   | 141.3 | 40.5 | 07   | 199.0 | 57.0 | 67   | 256.6 | 73.7 |
| 28   | 26.9 | 07.7 | 88   | 84.6  | 24.3 | 48   | 142.2 | 40.8 | 08   | 199.9 | 57.3 | 68   | 257.6 | 73.9 |
| 29   | 27.9 | 08.0 | 89   | 85.5  | 24.5 | 49   | 143.2 | 41.1 | 09   | 200.9 | 57.6 | 69   | 258.5 | 74.2 |
| 30   | 28.8 | 08.3 | 90   | 86.5  | 24.8 | 50   | 144.2 | 41.3 | 10   | 201.8 | 57.9 | 70   | 259.5 | 74.5 |
| 31   | 29.8 | 08.5 | 91   | 87.5  | 25.1 | 151  | 145.1 | 41.6 | 211  | 202.8 | 58.2 | 271  | 260.5 | 74.7 |
| 32   | 30.8 | 08.8 | 92   | 88.4  | 25.4 | 52   | 146.1 | 41.9 | 12   | 203.8 | 58.4 | 72   | 261.4 | 75.0 |
| 33   | 31.7 | 09.1 | 93   | 89.4  | 25.6 | 53   | 147.1 | 42.2 | 13   | 204.7 | 58.7 | 73   | 262.4 | 75.3 |
| 34   | 32.7 | 09.4 | 94   | 90.3  | 25.9 | 54   | 148.0 | 42.4 | 14   | 205.7 | 59.0 | 74   | 263.3 | 75.6 |
| 35   | 33.6 | 09.6 | 95   | 91.3  | 26.2 | 55   | 149.0 | 42.7 | 15   | 206.6 | 59.3 | 75   | 264.3 | 75.9 |
| 36   | 34.6 | 09.9 | 96   | 92.3  | 26.5 | 56   | 149.9 | 43.0 | 16   | 207.6 | 59.5 | 76   | 265.3 | 76.2 |
| 37   | 35.6 | 10.2 | 97   | 93.2  | 26.7 | 57   | 150.9 | 43.3 | 17   | 208.6 | 59.8 | 77   | 266.2 | 76.5 |
| 38   | 36.5 | 10.5 | 98   | 94.2  | 27.0 | 58   | 151.9 | 43.5 | 18   | 209.5 | 60.1 | 78   | 267.2 | 76.8 |
| 39   | 37.5 | 10.7 | 99   | 95.2  | 27.3 | 59   | 152.8 | 43.8 | 19   | 210.5 | 60.4 | 79   | 268.2 | 77.1 |
| 40   | 38.4 | 11.0 | 100  | 96.1  | 27.6 | 60   | 153.8 | 44.1 | 20   | 211.4 | 60.6 | 80   | 269.2 | 77.4 |
| 41   | 39.4 | 11.3 | 101  | 97.1  | 27.8 | 161  | 154.7 | 44.4 | 221  | 212.4 | 60.9 | 281  | 270.1 | 77.7 |
| 42   | 40.4 | 11.6 | 02   | 98.0  | 28.1 | 62   | 155.7 | 44.6 | 22   | 213.4 | 61.2 | 82   | 271.0 | 78.0 |
| 43   | 41.3 | 11.9 | 03   | 99.0  | 28.4 | 63   | 156.7 | 44.9 | 23   | 214.3 | 61.5 | 83   | 272.0 | 78.3 |
| 44   | 42.3 | 12.1 | 04   | 100.0 | 28.7 | 64   | 157.6 | 45.2 | 24   | 215.3 | 61.7 | 84   | 273.0 | 78.6 |
| 45   | 43.3 | 12.4 | 05   | 100.9 | 28.9 | 65   | 158.6 | 45.5 | 25   | 216.3 | 62.0 | 85   | 273.9 | 78.9 |
| 46   | 44.2 | 12.7 | 06   | 101.9 | 29.2 | 66   | 159.5 | 45.7 | 26   | 217.2 | 62.3 | 86   | 274.9 | 79.2 |
| 47   | 45.2 | 13.0 | 07   | 102.8 | 29.5 | 67   | 160.5 | 46.0 | 27   | 218.2 | 62.6 | 87   | 275.8 | 79.5 |
| 48   | 46.1 | 13.2 | 08   | 103.8 | 29.8 | 68   | 161.5 | 46.3 | 28   | 219.1 | 62.8 | 88   | 276.8 | 79.8 |
| 49   | 47.1 | 13.5 | 09   | 104.8 | 30.0 | 69   | 162.4 | 46.6 | 29   | 220.1 | 63.1 | 89   | 277.8 | 80.1 |
| 50   | 48.1 | 13.8 | 10   | 105.7 | 30.3 | 70   | 163.4 | 46.9 | 30   | 221.1 | 63.4 | 90   | 278.7 | 80.4 |
| 51   | 49.0 | 14.1 | 111  | 106.7 | 30.6 | 171  | 164.4 | 47.1 | 231  | 222.0 | 63.7 | 291  | 279.7 | 80.7 |
| 52   | 50.0 | 14.3 | 12   | 107.6 | 30.9 | 72   | 165.3 | 47.4 | 32   | 223.0 | 63.9 | 92   | 280.6 | 81.0 |
| 53   | 50.9 | 14.6 | 13   | 108.6 | 31.1 | 73   | 166.3 | 47.7 | 33   | 223.9 | 64.2 | 93   | 281.6 | 81.3 |
| 54   | 51.9 | 14.9 | 14   | 109.6 | 31.4 | 74   | 167.2 | 48.0 | 35   | 224.9 | 64.5 | 94   | 282.6 | 81.6 |
| 55   | 52.9 | 15.2 | 15   | 110.5 | 31.7 | 75   | 168.2 | 48.2 | 35   | 225.9 | 64.8 | 95   | 283.6 | 81.9 |
| 56   | 53.8 | 15.4 | 16   | 111.5 | 32.0 | 76   | 169.2 | 48.5 | 36   | 226.8 | 65.0 | 96   | 284.6 | 82.2 |
| 57   | 54.8 | 15.7 | 17   | 112.5 | 32.2 | 77   | 170.1 | 48.8 | 37   | 227.8 | 65.3 | 97   | 285.6 | 82.5 |
| 58   | 55.7 | 16.0 | 18   | 113.4 | 32.5 | 78   | 171.1 | 49.1 | 38   | 228.7 | 65.6 | 98   | 286.6 | 82.8 |
| 59   | 56.7 | 16.3 | 19   | 114.4 | 32.8 | 79   | 172.0 | 49.3 | 39   | 229.7 | 65.9 | 99   | 287.6 | 83.1 |
| 60   | 57.7 | 16.5 | 120  | 115.3 | 33.1 | 180  | 173.0 | 49.6 | 240  | 230.7 | 66.1 | 300  | 288.6 | 83.4 |

Diff Dep Lat Diff Dep Lat Diff Dep Lat Diff Dep Lat Diff Dep Lat

for 74 Degrees.

TABLE III. Difference of Latitude and Departure for 17 Degrees.

| Diff | Lat. | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 01.0 | 00.3 | 61   | 58.3  | 17.8 | 121  | 115.7 | 33.4 | 181  | 173.1 | 52.9 | 241  | 239.5 | 70.4 |
| 2    | 01.9 | 00.6 | 62   | 59.3  | 18.1 | 22   | 116.7 | 35.7 | 82   | 174.0 | 53.2 | 42   | 231.4 | 70.7 |
| 3    | 02.9 | 00.9 | 63   | 60.2  | 18.4 | 23   | 117.6 | 36.0 | 83   | 175.0 | 53.5 | 43   | 232.4 | 71.0 |
| 4    | 03.8 | 01.2 | 64   | 61.2  | 18.7 | 24   | 118.6 | 36.2 | 84   | 175.9 | 53.8 | 44   | 233.3 | 71.3 |
| 5    | 04.8 | 01.5 | 65   | 62.2  | 19.0 | 25   | 119.5 | 36.5 | 85   | 176.9 | 54.1 | 45   | 234.3 | 71.6 |
| 6    | 05.7 | 01.8 | 66   | 63.1  | 19.3 | 26   | 120.5 | 36.8 | 86   | 177.9 | 54.4 | 46   | 235.2 | 71.9 |
| 7    | 06.7 | 02.0 | 67   | 64.1  | 19.6 | 27   | 121.4 | 37.1 | 87   | 178.8 | 54.7 | 47   | 236.2 | 72.1 |
| 8    | 07.6 | 02.3 | 68   | 65.0  | 19.9 | 28   | 122.4 | 37.4 | 88   | 179.8 | 55.0 | 48   | 237.1 | 72.4 |
| 9    | 08.6 | 02.6 | 69   | 66.0  | 20.2 | 29   | 123.4 | 37.7 | 89   | 180.7 | 55.2 | 49   | 238.1 | 72.7 |
| 10   | 09.6 | 02.9 | 70   | 66.9  | 20.5 | 30   | 124.3 | 38.0 | 90   | 181.7 | 55.5 | 50   | 239.1 | 73.0 |
| 11   | 10.5 | 03.2 | 71   | 67.9  | 20.8 | 31   | 125.3 | 38.3 | 91   | 182.6 | 55.8 | 51   | 240.0 | 73.3 |
| 12   | 11.5 | 03.5 | 72   | 68.8  | 21.0 | 32   | 126.2 | 38.6 | 92   | 183.6 | 56.1 | 52   | 241.0 | 73.6 |
| 13   | 12.4 | 03.8 | 73   | 69.8  | 21.3 | 33   | 127.2 | 38.9 | 93   | 184.6 | 56.4 | 53   | 241.9 | 73.9 |
| 14   | 13.4 | 04.1 | 74   | 70.8  | 21.6 | 34   | 128.1 | 39.2 | 94   | 185.5 | 56.7 | 54   | 242.9 | 74.1 |
| 15   | 14.3 | 04.4 | 75   | 71.7  | 21.9 | 35   | 129.1 | 39.5 | 95   | 186.5 | 57.0 | 55   | 243.8 | 74.4 |
| 16   | 15.3 | 04.7 | 76   | 72.7  | 22.2 | 36   | 130.0 | 39.8 | 96   | 187.4 | 57.3 | 56   | 244.8 | 74.7 |
| 17   | 16.3 | 05.0 | 77   | 73.6  | 22.5 | 37   | 131.0 | 40.0 | 97   | 188.4 | 57.6 | 57   | 245.8 | 75.0 |
| 18   | 17.2 | 05.3 | 78   | 74.6  | 22.8 | 38   | 132.0 | 40.3 | 98   | 189.3 | 57.9 | 58   | 246.7 | 75.3 |
| 19   | 18.2 | 05.6 | 79   | 75.5  | 23.1 | 39   | 132.9 | 40.6 | 99   | 190.3 | 58.2 | 59   | 247.7 | 75.6 |
| 20   | 19.1 | 05.8 | 80   | 76.5  | 23.4 | 40   | 133.9 | 40.9 | 200  | 191.2 | 58.5 | 60   | 248.6 | 75.9 |
| 21   | 20.1 | 06.1 | 81   | 77.5  | 23.7 | 41   | 134.8 | 41.2 | 201  | 192.2 | 58.8 | 61   | 249.6 | 76.2 |
| 22   | 21.0 | 06.4 | 82   | 78.4  | 24.0 | 42   | 135.8 | 41.5 | 02   | 193.2 | 59.0 | 62   | 250.5 | 76.5 |
| 23   | 22.0 | 06.7 | 83   | 79.4  | 24.3 | 43   | 136.7 | 41.8 | 03   | 194.1 | 59.3 | 63   | 251.5 | 76.8 |
| 24   | 22.9 | 07.0 | 84   | 80.3  | 24.6 | 44   | 137.7 | 42.1 | 04   | 195.1 | 59.6 | 64   | 252.4 | 77.1 |
| 25   | 23.9 | 07.3 | 85   | 81.3  | 24.8 | 45   | 138.7 | 42.4 | 05   | 196.0 | 59.9 | 65   | 253.4 | 77.4 |
| 26   | 24.9 | 07.6 | 86   | 82.2  | 25.1 | 46   | 139.6 | 42.7 | 06   | 197.0 | 60.2 | 66   | 254.4 | 77.7 |
| 27   | 25.8 | 07.9 | 87   | 83.2  | 25.4 | 47   | 140.6 | 43.0 | 07   | 197.9 | 60.5 | 67   | 255.3 | 77.9 |
| 28   | 26.8 | 08.2 | 88   | 84.1  | 25.7 | 48   | 141.5 | 43.3 | 08   | 198.9 | 60.8 | 68   | 256.3 | 78.2 |
| 29   | 27.7 | 08.5 | 89   | 85.1  | 26.0 | 49   | 142.5 | 43.6 | 09   | 199.8 | 61.1 | 69   | 257.2 | 78.5 |
| 30   | 28.7 | 08.8 | 90   | 86.1  | 26.3 | 50   | 143.4 | 43.8 | 10   | 200.8 | 61.4 | 70   | 258.2 | 78.8 |
| 31   | 29.6 | 09.1 | 91   | 87.0  | 26.6 | 51   | 144.4 | 44.1 | 211  | 201.8 | 61.7 | 271  | 259.1 | 79.1 |
| 32   | 30.6 | 09.4 | 92   | 88.0  | 26.9 | 52   | 145.3 | 44.4 | 12   | 202.7 | 62.0 | 72   | 260.1 | 79.4 |
| 33   | 31.6 | 09.6 | 93   | 88.9  | 27.2 | 53   | 146.3 | 44.7 | 13   | 203.7 | 62.3 | 73   | 261.1 | 79.7 |
| 34   | 32.5 | 09.9 | 94   | 89.9  | 27.5 | 54   | 147.3 | 45.0 | 14   | 204.6 | 62.6 | 74   | 262.0 | 80.0 |
| 35   | 33.5 | 10.2 | 95   | 90.8  | 27.8 | 55   | 148.2 | 45.3 | 15   | 205.6 | 62.8 | 75   | 263.0 | 80.3 |
| 36   | 34.4 | 10.5 | 96   | 91.8  | 28.1 | 56   | 149.2 | 45.6 | 16   | 206.5 | 63.1 | 76   | 263.9 | 80.6 |
| 37   | 35.4 | 10.8 | 97   | 92.8  | 28.4 | 57   | 150.1 | 45.9 | 17   | 207.5 | 63.4 | 77   | 264.9 | 80.9 |
| 38   | 36.3 | 11.1 | 98   | 93.7  | 28.6 | 58   | 151.1 | 46.2 | 18   | 208.5 | 63.7 | 78   | 265.8 | 81.2 |
| 39   | 37.3 | 11.4 | 99   | 94.7  | 28.9 | 59   | 152.0 | 46.5 | 19   | 209.4 | 64.0 | 79   | 266.8 | 81.4 |
| 40   | 38.2 | 11.7 | 100  | 95.6  | 29.2 | 60   | 153.0 | 46.8 | 20   | 210.4 | 64.3 | 80   | 267.7 | 81.7 |
| 41   | 39.2 | 12.0 | 101  | 96.6  | 29.5 | 61   | 154.0 | 47.1 | 221  | 211.3 | 64.6 | 281  | 268.7 | 82.0 |
| 42   | 40.2 | 12.3 | 02   | 97.5  | 29.8 | 62   | 154.9 | 47.4 | 22   | 212.3 | 64.9 | 82   | 269.7 | 82.3 |
| 43   | 41.1 | 12.6 | 03   | 98.5  | 30.1 | 63   | 155.9 | 47.6 | 23   | 213.2 | 65.2 | 83   | 270.6 | 82.6 |
| 44   | 42.1 | 12.9 | 04   | 99.4  | 30.4 | 64   | 156.8 | 47.9 | 24   | 214.2 | 65.5 | 84   | 271.6 | 82.9 |
| 45   | 43.0 | 13.2 | 05   | 100.4 | 30.7 | 65   | 157.8 | 48.2 | 25   | 215.2 | 65.8 | 85   | 272.5 | 83.2 |
| 46   | 44.0 | 13.4 | 06   | 101.4 | 31.0 | 66   | 158.7 | 48.5 | 26   | 216.1 | 66.1 | 86   | 273.5 | 83.5 |
| 47   | 44.9 | 13.7 | 07   | 102.3 | 31.3 | 67   | 159.7 | 48.8 | 27   | 217.1 | 66.4 | 87   | 274.4 | 83.8 |
| 48   | 45.9 | 14.0 | 08   | 103.3 | 31.6 | 68   | 160.6 | 49.1 | 28   | 218.0 | 66.6 | 88   | 275.4 | 84.1 |
| 49   | 46.9 | 14.3 | 09   | 104.2 | 31.9 | 69   | 161.6 | 49.4 | 29   | 219.0 | 66.9 | 89   | 276.4 | 84.4 |
| 50   | 47.8 | 14.6 | 10   | 105.2 | 32.2 | 70   | 162.6 | 49.7 | 30   | 219.9 | 67.2 | 90   | 277.3 | 84.7 |
| 51   | 48.8 | 14.9 | 111  | 106.1 | 32.4 | 171  | 163.5 | 50.0 | 231  | 220.9 | 67.5 | 291  | 278.3 | 85.0 |
| 52   | 49.7 | 15.2 | 12   | 107.1 | 32.7 | 72   | 164.5 | 50.3 | 32   | 221.8 | 67.8 | 92   | 279.2 | 85.3 |
| 53   | 50.7 | 15.5 | 13   | 108.1 | 33.0 | 73   | 165.4 | 50.6 | 33   | 222.8 | 68.1 | 93   | 280.2 | 85.5 |
| 54   | 51.6 | 15.8 | 14   | 109.0 | 33.3 | 74   | 166.4 | 50.9 | 34   | 223.8 | 68.4 | 94   | 281.1 | 85.8 |
| 55   | 52.6 | 16.1 | 15   | 110.0 | 33.6 | 75   | 167.3 | 51.2 | 35   | 224.7 | 68.7 | 95   | 282.1 | 86.1 |
| 56   | 53.5 | 16.4 | 16   | 110.9 | 33.9 | 76   | 168.3 | 51.4 | 36   | 225.7 | 69.0 | 96   | 283.0 | 86.4 |
| 57   | 54.5 | 16.7 | 17   | 111.9 | 34.2 | 77   | 169.3 | 51.7 | 37   | 226.6 | 69.3 | 97   | 284.0 | 86.7 |
| 58   | 55.5 | 17.0 | 18   | 112.8 | 34.5 | 78   | 170.2 | 52.0 | 38   | 227.6 | 69.6 | 98   | 285.0 | 87.0 |
| 59   | 56.4 | 17.2 | 19   | 113.8 | 34.8 | 79   | 171.2 | 52.3 | 39   | 228.5 | 69.9 | 99   | 285.9 | 87.3 |
| 60   | 57.4 | 17.5 | 120  | 114.7 | 35.1 | 80   | 172.1 | 52.6 | 140  | 229.5 | 70.2 | 300  | 286.9 | 87.6 |
| Diff | Dep  | Lat. | Diff | Dep.  | Lat. | Diff | Dep.  | Lat. | Diff | Dep.  | Lat. | Diff | Dep.  | Lat. |

for 73 Degrees.

TABLE III. Difference of Latitude and Departure for 18 Degrees

| Dist | Lat  | Dep   | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep   |
|------|------|-------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|-------|
| 1    | 01.0 | 003.3 | 61   | 58.0  | 18.8 | 121  | 119.1 | 37.4 | 181  | 172.1 | 55.9 | 241  | 129.7 | 74.5 | 301  | 189.7 | 93.1  |
| 2    | 01.9 | 006.6 | 62   | 59.0  | 19.2 | 122  | 116.0 | 37.7 | 82   | 173.1 | 56.2 | 42   | 130.0 | 74.8 | 302  | 190.6 | 93.4  |
| 3    | 02.9 | 009.9 | 63   | 59.9  | 19.5 | 23   | 117.0 | 38.0 | 83   | 174.0 | 56.5 | 43   | 131.0 | 75.1 | 303  | 191.5 | 93.7  |
| 4    | 03.8 | 012.2 | 64   | 60.9  | 19.8 | 24   | 117.9 | 38.3 | 84   | 175.0 | 56.9 | 44   | 132.0 | 75.4 | 304  | 192.4 | 94.0  |
| 5    | 04.8 | 015.5 | 65   | 61.8  | 20.1 | 25   | 118.9 | 38.6 | 85   | 175.9 | 57.2 | 45   | 133.0 | 75.7 | 305  | 193.3 | 94.3  |
| 6    | 05.7 | 018.9 | 66   | 62.8  | 20.4 | 26   | 119.8 | 38.9 | 86   | 176.9 | 57.5 | 46   | 134.0 | 76.0 | 306  | 194.2 | 94.6  |
| 7    | 06.7 | 022.2 | 67   | 63.7  | 20.7 | 27   | 120.8 | 39.2 | 87   | 177.8 | 57.8 | 47   | 135.0 | 76.3 | 307  | 195.1 | 94.9  |
| 8    | 07.6 | 025.5 | 68   | 64.7  | 21.0 | 28   | 121.7 | 39.6 | 88   | 178.8 | 58.1 | 48   | 136.0 | 76.6 | 308  | 196.0 | 95.2  |
| 9    | 08.6 | 028.8 | 69   | 65.6  | 21.3 | 29   | 122.7 | 39.9 | 89   | 179.7 | 58.4 | 49   | 137.0 | 76.9 | 309  | 196.9 | 95.5  |
| 10   | 09.5 | 031.1 | 70   | 66.6  | 21.6 | 30   | 123.6 | 40.2 | 90   | 180.7 | 58.7 | 50   | 138.0 | 77.1 | 310  | 197.8 | 95.8  |
| 11   | 10.5 | 034.4 | 71   | 67.5  | 21.9 | 131  | 124.6 | 40.5 | 91   | 181.6 | 59.0 | 251  | 138.7 | 77.6 | 311  | 198.7 | 96.1  |
| 12   | 11.4 | 037.7 | 72   | 68.5  | 22.2 | 32   | 125.5 | 40.8 | 92   | 182.6 | 59.3 | 32   | 139.7 | 77.9 | 312  | 199.6 | 96.4  |
| 13   | 12.4 | 041.0 | 73   | 69.4  | 22.6 | 33   | 126.5 | 41.1 | 93   | 183.5 | 59.6 | 53   | 140.6 | 78.2 | 313  | 200.5 | 96.7  |
| 14   | 13.3 | 044.3 | 74   | 70.4  | 22.9 | 34   | 127.4 | 41.4 | 94   | 184.5 | 59.9 | 54   | 141.6 | 78.5 | 314  | 201.4 | 97.0  |
| 15   | 14.3 | 047.6 | 75   | 71.3  | 23.2 | 35   | 128.4 | 41.7 | 95   | 185.4 | 60.3 | 55   | 142.5 | 78.8 | 315  | 202.3 | 97.3  |
| 16   | 15.2 | 050.9 | 76   | 72.3  | 23.5 | 36   | 129.3 | 42.0 | 96   | 186.4 | 60.6 | 56   | 143.5 | 79.1 | 316  | 203.2 | 97.6  |
| 17   | 16.2 | 054.2 | 77   | 73.2  | 23.8 | 37   | 130.3 | 42.3 | 97   | 187.3 | 60.9 | 57   | 144.4 | 79.4 | 317  | 204.1 | 97.9  |
| 18   | 17.1 | 057.5 | 78   | 74.2  | 24.1 | 38   | 131.2 | 42.6 | 98   | 188.3 | 61.2 | 58   | 145.4 | 79.7 | 318  | 205.0 | 98.2  |
| 19   | 18.1 | 059.9 | 79   | 75.1  | 24.4 | 39   | 132.2 | 43.0 | 99   | 189.2 | 61.5 | 59   | 146.3 | 80.0 | 319  | 205.9 | 98.5  |
| 20   | 19.0 | 062.2 | 80   | 76.1  | 24.7 | 40   | 133.1 | 43.3 | 200  | 190.2 | 61.8 | 60   | 147.3 | 80.3 | 320  | 206.8 | 98.8  |
| 21   | 20.0 | 065.5 | 81   | 77.0  | 25.0 | 141  | 134.1 | 43.6 | 201  | 191.2 | 62.1 | 261  | 148.0 | 80.6 | 321  | 207.7 | 99.1  |
| 22   | 20.9 | 068.8 | 82   | 78.0  | 25.3 | 42   | 135.0 | 43.9 | 02   | 192.1 | 62.4 | 62   | 149.0 | 80.9 | 322  | 208.6 | 99.4  |
| 23   | 21.9 | 071.1 | 83   | 78.9  | 25.6 | 43   | 136.0 | 44.2 | 03   | 193.1 | 62.7 | 63   | 150.1 | 81.2 | 323  | 209.5 | 99.7  |
| 24   | 22.8 | 074.4 | 84   | 79.9  | 26.0 | 44   | 136.9 | 44.5 | 04   | 194.0 | 63.0 | 64   | 151.1 | 81.5 | 324  | 210.4 | 100.0 |
| 25   | 23.8 | 077.7 | 85   | 80.8  | 26.3 | 45   | 137.9 | 44.8 | 05   | 195.0 | 63.3 | 65   | 152.0 | 81.8 | 325  | 211.3 | 100.3 |
| 26   | 24.7 | 080.0 | 86   | 81.8  | 26.6 | 46   | 138.8 | 45.1 | 06   | 195.9 | 63.7 | 66   | 153.0 | 82.1 | 326  | 212.2 | 100.6 |
| 27   | 25.7 | 083.3 | 87   | 82.7  | 26.9 | 47   | 139.8 | 45.4 | 07   | 196.9 | 64.0 | 67   | 154.0 | 82.4 | 327  | 213.1 | 100.9 |
| 28   | 26.6 | 086.6 | 88   | 83.7  | 27.2 | 48   | 140.7 | 45.7 | 08   | 197.8 | 64.3 | 68   | 155.0 | 82.7 | 328  | 214.0 | 101.2 |
| 29   | 27.6 | 089.9 | 89   | 84.6  | 27.5 | 49   | 141.7 | 46.0 | 09   | 198.8 | 64.6 | 69   | 156.0 | 83.0 | 329  | 214.9 | 101.5 |
| 30   | 28.5 | 093.2 | 90   | 85.6  | 27.8 | 50   | 142.7 | 46.3 | 10   | 199.7 | 64.9 | 70   | 157.0 | 83.3 | 330  | 215.8 | 101.8 |
| 31   | 29.5 | 096.5 | 91   | 86.5  | 28.1 | 151  | 143.6 | 46.7 | 211  | 200.7 | 65.2 | 271  | 157.7 | 83.7 | 331  | 216.7 | 102.1 |
| 32   | 30.4 | 099.8 | 92   | 87.5  | 28.4 | 52   | 144.6 | 47.0 | 12   | 201.6 | 65.5 | 72   | 158.7 | 84.0 | 332  | 217.6 | 102.4 |
| 33   | 31.4 | 102.2 | 93   | 88.4  | 28.7 | 53   | 145.5 | 47.3 | 13   | 202.6 | 65.8 | 73   | 159.6 | 84.3 | 333  | 218.5 | 102.7 |
| 34   | 32.3 | 105.5 | 94   | 89.4  | 29.0 | 54   | 146.5 | 47.6 | 14   | 203.5 | 66.1 | 74   | 160.6 | 84.6 | 334  | 219.4 | 103.0 |
| 35   | 33.3 | 108.8 | 95   | 90.3  | 29.4 | 55   | 147.4 | 47.9 | 15   | 204.5 | 66.4 | 75   | 161.5 | 84.9 | 335  | 220.3 | 103.3 |
| 36   | 34.2 | 112.1 | 96   | 91.3  | 29.7 | 56   | 148.4 | 48.2 | 16   | 205.4 | 66.7 | 76   | 162.5 | 85.2 | 336  | 221.2 | 103.6 |
| 37   | 35.2 | 115.4 | 97   | 92.2  | 30.0 | 57   | 149.3 | 48.5 | 17   | 206.4 | 67.1 | 77   | 163.4 | 85.5 | 337  | 222.1 | 103.9 |
| 38   | 36.1 | 118.7 | 98   | 93.2  | 30.3 | 58   | 150.3 | 48.8 | 18   | 207.3 | 67.4 | 78   | 164.4 | 85.8 | 338  | 223.0 | 104.2 |
| 39   | 37.1 | 122.0 | 99   | 94.1  | 30.6 | 59   | 151.2 | 49.1 | 19   | 208.3 | 67.7 | 79   | 165.3 | 86.1 | 339  | 223.9 | 104.5 |
| 40   | 38.0 | 125.3 | 100  | 95.1  | 30.9 | 60   | 152.2 | 49.4 | 20   | 209.2 | 68.0 | 80   | 166.3 | 86.4 | 340  | 224.8 | 104.8 |
| 41   | 39.0 | 128.6 | 101  | 96.1  | 31.2 | 161  | 153.1 | 49.7 | 221  | 210.2 | 68.3 | 281  | 167.2 | 86.7 | 341  | 225.7 | 105.1 |
| 42   | 39.9 | 131.9 | 02   | 97.0  | 31.5 | 62   | 154.1 | 50.1 | 22   | 211.1 | 68.6 | 82   | 168.2 | 87.0 | 342  | 226.6 | 105.4 |
| 43   | 40.9 | 135.2 | 03   | 98.0  | 31.8 | 63   | 155.0 | 50.4 | 23   | 212.1 | 68.9 | 83   | 169.1 | 87.3 | 343  | 227.5 | 105.7 |
| 44   | 41.8 | 138.5 | 04   | 98.9  | 32.1 | 64   | 156.0 | 50.7 | 24   | 213.0 | 69.2 | 84   | 170.1 | 87.6 | 344  | 228.4 | 106.0 |
| 45   | 42.8 | 141.8 | 05   | 99.9  | 32.4 | 65   | 156.9 | 51.0 | 25   | 214.0 | 69.5 | 85   | 171.0 | 87.9 | 345  | 229.3 | 106.3 |
| 46   | 43.7 | 145.1 | 06   | 100.8 | 32.8 | 66   | 157.9 | 51.3 | 26   | 214.9 | 69.8 | 86   | 172.0 | 88.2 | 346  | 230.2 | 106.6 |
| 47   | 44.7 | 148.4 | 07   | 101.8 | 33.1 | 67   | 158.8 | 51.6 | 27   | 215.9 | 70.1 | 87   | 172.9 | 88.5 | 347  | 231.1 | 106.9 |
| 48   | 45.6 | 151.7 | 08   | 102.7 | 33.4 | 68   | 159.8 | 51.9 | 28   | 216.8 | 70.4 | 88   | 173.9 | 88.8 | 348  | 232.0 | 107.2 |
| 49   | 46.6 | 155.0 | 09   | 103.7 | 33.7 | 69   | 160.7 | 52.2 | 29   | 217.8 | 70.8 | 89   | 174.8 | 89.1 | 349  | 232.9 | 107.5 |
| 50   | 47.6 | 158.3 | 10   | 104.6 | 34.0 | 70   | 161.7 | 52.5 | 30   | 218.7 | 71.1 | 90   | 175.8 | 89.4 | 350  | 233.8 | 107.8 |
| 51   | 48.5 | 161.6 | 111  | 105.6 | 34.3 | 171  | 162.6 | 52.8 | 231  | 219.7 | 71.4 | 291  | 176.7 | 89.7 | 351  | 234.7 | 108.1 |
| 52   | 49.5 | 164.9 | 12   | 106.5 | 34.6 | 72   | 163.6 | 53.1 | 32   | 220.6 | 71.7 | 92   | 177.7 | 90.0 | 352  | 235.6 | 108.4 |
| 53   | 50.4 | 168.2 | 13   | 107.5 | 34.9 | 73   | 164.5 | 53.5 | 33   | 221.6 | 72.0 | 93   | 178.6 | 90.3 | 353  | 236.5 | 108.7 |
| 54   | 51.4 | 171.5 | 14   | 108.4 | 35.2 | 74   | 165.5 | 53.8 | 34   | 222.5 | 72.3 | 94   | 179.6 | 90.6 | 354  | 237.4 | 109.0 |
| 55   | 52.3 | 174.8 | 15   | 109.4 | 35.5 | 75   | 166.4 | 54.1 | 35   | 223.5 | 72.6 | 95   | 180.5 | 90.9 | 355  | 238.3 | 109.3 |
| 56   | 53.3 | 178.1 | 16   | 110.3 | 35.8 | 76   | 167.4 | 54.4 | 36   | 224.4 | 72.9 | 96   | 181.5 | 91.2 | 356  | 239.2 | 109.6 |
| 57   | 54.2 | 181.4 | 17   | 111.3 | 36.2 | 77   | 168.3 | 54.7 | 37   | 225.4 | 73.2 | 97   | 182.4 | 91.5 | 357  | 240.1 | 109.9 |
| 58   | 55.2 | 184.7 | 18   | 112.2 | 36.5 | 78   | 169.3 | 55.0 | 38   | 226.3 | 73.5 | 98   | 183.4 | 91.8 | 358  | 241.0 | 110.2 |
| 59   | 56.1 | 188.0 | 19   | 113.2 | 36.8 | 79   | 170.2 | 55.3 | 39   | 227.3 | 73.9 | 99   | 184.3 | 92.1 | 359  | 241.9 | 110.5 |
| 60   | 57.1 | 191.3 | 120  | 114.1 | 37.1 | 180  | 171.2 | 55.6 | 240  | 228.2 | 74.2 | 300  | 185.3 | 92.4 | 360  | 242.8 | 110.8 |
| Dist | Dep  | Lat   | Dist | Dep   | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat   |

for 72 Degrees.



TABLE III. Difference of Latitude and Departure for 19 Degrees.

| Diff | Lat. | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|------|
| 1    | 00.9 | 00.3 | 61   | 57.7  | 19.9 | 121  | 114.4 | 39.4 | 181  | 171.1 | 58.9 | 241  | 227.9 | 78.5 |
| 2    | 01.9 | 00.7 | 62   | 58.6  | 20.2 | 122  | 115.3 | 39.7 | 82   | 172.1 | 59.3 | 42   | 228.8 | 78.8 |
| 3    | 02.8 | 01.0 | 63   | 59.6  | 20.5 | 23   | 116.3 | 40.0 | 83   | 173.0 | 59.6 | 43   | 229.7 | 79.1 |
| 4    | 03.8 | 01.3 | 64   | 60.5  | 20.8 | 24   | 117.2 | 40.4 | 84   | 174.0 | 59.9 | 44   | 230.7 | 79.4 |
| 5    | 04.7 | 01.6 | 65   | 61.5  | 21.2 | 25   | 118.2 | 40.7 | 85   | 174.9 | 60.2 | 45   | 231.6 | 79.8 |
| 6    | 05.7 | 02.0 | 66   | 62.4  | 21.5 | 26   | 119.1 | 41.0 | 86   | 175.9 | 60.6 | 46   | 232.6 | 80.1 |
| 7    | 06.6 | 02.3 | 67   | 63.3  | 21.8 | 27   | 120.1 | 41.4 | 87   | 176.8 | 60.9 | 47   | 233.5 | 80.4 |
| 8    | 07.6 | 02.6 | 68   | 64.3  | 22.1 | 28   | 121.0 | 41.7 | 88   | 177.7 | 61.2 | 48   | 234.5 | 80.7 |
| 9    | 08.5 | 02.9 | 69   | 65.2  | 22.5 | 29   | 122.0 | 42.0 | 89   | 178.7 | 61.5 | 49   | 235.4 | 81.1 |
| 10   | 09.5 | 03.3 | 70   | 66.2  | 22.8 | 30   | 122.9 | 42.3 | 90   | 179.6 | 61.9 | 50   | 236.4 | 81.4 |
| 11   | 10.4 | 03.6 | 71   | 67.1  | 23.1 | 131  | 123.9 | 42.7 | 191  | 180.6 | 62.2 | 251  | 237.3 | 81.7 |
| 12   | 11.3 | 03.9 | 72   | 68.1  | 23.4 | 32   | 124.8 | 43.0 | 92   | 181.5 | 62.5 | 52   | 238.3 | 82.1 |
| 13   | 12.3 | 04.2 | 73   | 69.0  | 23.8 | 33   | 125.7 | 43.3 | 93   | 182.5 | 62.8 | 53   | 239.2 | 82.4 |
| 14   | 13.2 | 04.6 | 74   | 70.0  | 24.1 | 34   | 126.7 | 43.6 | 94   | 183.4 | 63.2 | 54   | 240.1 | 82.7 |
| 15   | 14.2 | 04.9 | 75   | 70.9  | 24.4 | 35   | 127.6 | 44.0 | 95   | 184.4 | 63.5 | 55   | 241.1 | 83.0 |
| 16   | 15.1 | 05.2 | 76   | 71.9  | 24.7 | 36   | 128.6 | 44.3 | 96   | 185.3 | 63.8 | 56   | 242.0 | 83.4 |
| 17   | 16.1 | 05.5 | 77   | 72.8  | 25.1 | 37   | 129.5 | 44.6 | 97   | 186.3 | 64.1 | 57   | 243.0 | 83.7 |
| 18   | 17.0 | 05.9 | 78   | 73.7  | 25.4 | 38   | 130.5 | 44.9 | 98   | 187.2 | 64.5 | 58   | 243.9 | 84.0 |
| 19   | 18.0 | 06.2 | 79   | 74.7  | 25.7 | 39   | 131.4 | 45.3 | 99   | 188.1 | 64.8 | 59   | 244.9 | 84.3 |
| 20   | 18.9 | 06.5 | 80   | 75.6  | 26.0 | 40   | 132.4 | 45.6 | 200  | 189.1 | 65.1 | 60   | 245.8 | 84.7 |
| 21   | 19.9 | 06.8 | 81   | 76.6  | 26.4 | 141  | 133.3 | 45.9 | 201  | 190.0 | 65.4 | 261  | 246.8 | 85.0 |
| 22   | 20.8 | 07.2 | 82   | 77.5  | 26.7 | 42   | 134.3 | 46.2 | 02   | 191.0 | 65.8 | 62   | 247.7 | 85.3 |
| 23   | 21.7 | 07.5 | 83   | 78.5  | 27.0 | 43   | 135.2 | 46.6 | 03   | 191.9 | 66.1 | 63   | 248.7 | 85.6 |
| 24   | 22.7 | 07.8 | 84   | 79.4  | 27.4 | 44   | 136.1 | 46.9 | 04   | 192.9 | 66.4 | 64   | 249.6 | 86.0 |
| 25   | 23.6 | 08.1 | 85   | 80.4  | 27.7 | 45   | 137.1 | 47.2 | 05   | 193.8 | 66.7 | 65   | 250.5 | 86.3 |
| 26   | 24.6 | 08.5 | 86   | 81.3  | 28.0 | 46   | 138.0 | 47.5 | 06   | 194.8 | 67.1 | 66   | 251.5 | 86.6 |
| 27   | 25.5 | 08.8 | 87   | 82.3  | 28.3 | 47   | 139.0 | 47.9 | 07   | 195.7 | 67.4 | 67   | 252.4 | 86.9 |
| 28   | 26.5 | 09.1 | 88   | 83.2  | 28.7 | 48   | 139.9 | 48.2 | 08   | 196.7 | 67.7 | 68   | 253.4 | 87.3 |
| 29   | 27.4 | 09.4 | 89   | 84.1  | 29.0 | 49   | 140.9 | 48.5 | 09   | 197.6 | 68.1 | 69   | 254.3 | 87.6 |
| 30   | 28.4 | 09.8 | 90   | 85.1  | 29.3 | 50   | 141.8 | 48.8 | 10   | 198.5 | 68.4 | 70   | 255.3 | 87.9 |
| 31   | 29.3 | 10.1 | 91   | 86.0  | 29.6 | 151  | 142.8 | 49.2 | 211  | 199.5 | 68.7 | 271  | 256.2 | 88.2 |
| 32   | 30.3 | 10.4 | 92   | 87.0  | 30.0 | 52   | 143.7 | 49.5 | 12   | 200.4 | 69.0 | 72   | 257.2 | 88.6 |
| 33   | 31.1 | 10.7 | 93   | 87.9  | 30.3 | 53   | 144.7 | 49.8 | 13   | 201.4 | 69.4 | 73   | 258.1 | 88.9 |
| 34   | 32.1 | 11.1 | 94   | 88.9  | 30.6 | 54   | 145.6 | 50.1 | 14   | 202.3 | 69.7 | 74   | 259.1 | 89.2 |
| 35   | 33.1 | 11.4 | 95   | 89.8  | 30.9 | 55   | 146.5 | 50.5 | 15   | 203.3 | 70.0 | 75   | 260.0 | 89.5 |
| 36   | 34.0 | 11.7 | 96   | 90.8  | 31.3 | 56   | 147.5 | 50.8 | 16   | 204.2 | 70.3 | 76   | 260.9 | 89.9 |
| 37   | 35.0 | 12.0 | 97   | 91.7  | 31.6 | 57   | 148.4 | 51.1 | 17   | 205.2 | 70.7 | 77   | 261.9 | 90.2 |
| 38   | 35.9 | 12.4 | 98   | 92.7  | 31.9 | 58   | 149.4 | 51.4 | 18   | 206.1 | 71.0 | 78   | 262.8 | 90.5 |
| 39   | 36.9 | 12.7 | 99   | 93.6  | 32.2 | 59   | 150.3 | 51.8 | 19   | 207.1 | 71.3 | 79   | 263.8 | 90.8 |
| 40   | 37.8 | 13.0 | 100  | 94.5  | 32.6 | 60   | 151.3 | 52.1 | 20   | 208.0 | 71.6 | 80   | 264.7 | 91.2 |
| 41   | 38.8 | 13.3 | 101  | 95.5  | 32.9 | 161  | 152.2 | 52.4 | 221  | 208.9 | 72.0 | 281  | 265.7 | 91.5 |
| 42   | 39.7 | 13.7 | 02   | 96.4  | 33.2 | 62   | 153.2 | 52.7 | 22   | 209.9 | 72.3 | 82   | 266.6 | 91.8 |
| 43   | 40.7 | 14.0 | 03   | 97.4  | 33.5 | 63   | 154.1 | 53.1 | 23   | 210.8 | 72.6 | 83   | 267.6 | 92.1 |
| 44   | 41.6 | 14.3 | 04   | 98.3  | 33.9 | 64   | 155.1 | 53.4 | 24   | 211.8 | 72.9 | 84   | 268.5 | 92.5 |
| 45   | 42.5 | 14.7 | 05   | 99.3  | 34.2 | 65   | 156.0 | 53.7 | 25   | 212.7 | 73.3 | 85   | 269.5 | 92.8 |
| 46   | 43.5 | 15.0 | 06   | 100.2 | 34.5 | 66   | 156.9 | 54.0 | 26   | 213.7 | 73.6 | 86   | 270.4 | 93.1 |
| 47   | 44.4 | 15.3 | 07   | 101.2 | 34.8 | 67   | 157.9 | 54.4 | 27   | 214.6 | 73.9 | 87   | 271.4 | 93.4 |
| 48   | 45.4 | 15.6 | 08   | 102.1 | 35.2 | 68   | 158.8 | 54.7 | 28   | 215.6 | 74.2 | 88   | 272.3 | 93.8 |
| 49   | 46.3 | 16.0 | 09   | 103.1 | 35.5 | 69   | 159.8 | 55.0 | 29   | 216.5 | 74.6 | 89   | 273.2 | 94.1 |
| 50   | 47.3 | 16.3 | 10   | 104.0 | 35.8 | 70   | 160.7 | 55.4 | 30   | 217.5 | 74.9 | 90   | 274.2 | 94.4 |
| 51   | 48.2 | 16.6 | 111  | 104.9 | 36.1 | 171  | 161.7 | 55.7 | 231  | 218.4 | 75.2 | 291  | 275.1 | 94.7 |
| 52   | 49.2 | 16.9 | 12   | 105.9 | 36.5 | 72   | 162.6 | 56.0 | 32   | 219.3 | 75.5 | 92   | 276.1 | 95.1 |
| 53   | 50.1 | 17.3 | 13   | 106.8 | 36.8 | 73   | 163.6 | 56.3 | 33   | 220.3 | 75.9 | 93   | 277.0 | 95.4 |
| 54   | 51.1 | 17.6 | 14   | 107.8 | 37.1 | 74   | 164.5 | 56.7 | 34   | 221.2 | 76.2 | 94   | 278.0 | 95.7 |
| 55   | 52.0 | 17.9 | 15   | 108.7 | 37.4 | 75   | 165.5 | 57.0 | 35   | 222.2 | 76.5 | 95   | 278.9 | 96.0 |
| 56   | 52.9 | 18.2 | 16   | 109.7 | 37.8 | 76   | 166.4 | 57.3 | 36   | 223.1 | 76.8 | 96   | 279.9 | 96.4 |
| 57   | 53.9 | 18.6 | 17   | 110.6 | 38.1 | 77   | 167.3 | 57.6 | 37   | 224.1 | 77.2 | 97   | 280.8 | 96.7 |
| 58   | 54.8 | 18.9 | 18   | 111.6 | 38.4 | 78   | 168.3 | 58.0 | 38   | 225.0 | 77.5 | 98   | 281.7 | 97.0 |
| 59   | 55.8 | 19.2 | 19   | 112.5 | 38.7 | 79   | 169.2 | 58.3 | 39   | 226.0 | 77.8 | 99   | 282.7 | 97.4 |
| 60   | 56.7 | 19.5 | 120  | 113.5 | 39.1 | 180  | 170.2 | 58.6 | 40   | 226.9 | 78.1 | 300  | 283.6 | 97.7 |

F f

for 71 Degrees.

TABLE III. Difference of Latitude and Departure for 20 Degrees.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep   | Dist | Lat.  | Dep   |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|
| 1    | 00.9 | 00.3 | 61   | 57.3  | 20.9 | 121  | 113.7 | 41.4 | 181  | 170.1 | 61.9 | 241  | 226.5 | 82.4  | 301  | 283.1 | 102.9 |
| 2    | 01.9 | 00.7 | 62   | 58.3  | 21.2 | 22   | 114.6 | 41.7 | 82   | 171.0 | 62.2 | 42   | 227.4 | 82.8  | 102  | 284.1 | 103.2 |
| 3    | 02.8 | 01.0 | 63   | 59.2  | 21.5 | 23   | 115.6 | 42.1 | 83   | 172.0 | 62.6 | 43   | 228.3 | 83.1  | 103  | 285.1 | 103.5 |
| 4    | 03.8 | 01.4 | 64   | 60.1  | 21.9 | 24   | 116.5 | 42.4 | 84   | 172.9 | 62.9 | 44   | 229.3 | 83.4  | 104  | 286.1 | 103.8 |
| 5    | 04.7 | 01.7 | 65   | 61.1  | 22.2 | 25   | 117.5 | 42.8 | 85   | 173.8 | 63.3 | 45   | 230.2 | 83.8  | 105  | 287.1 | 104.1 |
| 6    | 05.6 | 02.1 | 66   | 62.0  | 22.6 | 26   | 118.4 | 43.1 | 86   | 174.8 | 63.6 | 46   | 231.2 | 84.1  | 106  | 288.1 | 104.4 |
| 7    | 06.6 | 02.4 | 67   | 63.0  | 22.9 | 27   | 119.3 | 43.4 | 87   | 175.7 | 64.0 | 47   | 232.1 | 84.5  | 107  | 289.1 | 104.7 |
| 8    | 07.5 | 02.7 | 68   | 63.9  | 23.3 | 28   | 120.3 | 43.8 | 88   | 176.7 | 64.3 | 48   | 233.0 | 84.8  | 108  | 290.1 | 105.0 |
| 9    | 08.5 | 03.1 | 69   | 64.8  | 23.6 | 29   | 121.2 | 44.1 | 89   | 177.6 | 64.6 | 49   | 234.0 | 85.2  | 109  | 291.1 | 105.3 |
| 10   | 09.4 | 03.4 | 70   | 65.8  | 23.9 | 30   | 122.2 | 44.5 | 90   | 178.5 | 65.0 | 50   | 234.9 | 85.5  | 110  | 292.1 | 105.6 |
| 11   | 10.3 | 03.8 | 71   | 66.7  | 24.3 | 31   | 123.1 | 44.8 | 191  | 179.5 | 65.3 | 51   | 235.9 | 85.8  | 111  | 293.1 | 105.9 |
| 12   | 11.3 | 04.1 | 72   | 67.7  | 24.6 | 32   | 124.0 | 45.1 | 92   | 180.4 | 65.7 | 52   | 236.8 | 86.2  | 112  | 294.1 | 106.2 |
| 13   | 12.2 | 04.4 | 73   | 68.6  | 25.0 | 33   | 125.0 | 45.5 | 93   | 181.4 | 66.0 | 53   | 237.7 | 86.5  | 113  | 295.1 | 106.5 |
| 14   | 13.2 | 04.8 | 74   | 69.5  | 25.3 | 34   | 125.9 | 45.8 | 94   | 182.3 | 66.3 | 54   | 238.7 | 86.9  | 114  | 296.1 | 106.8 |
| 15   | 14.1 | 05.1 | 75   | 70.5  | 25.7 | 35   | 126.9 | 46.2 | 95   | 183.2 | 66.7 | 55   | 239.6 | 87.2  | 115  | 297.1 | 107.1 |
| 16   | 15.0 | 05.5 | 76   | 71.4  | 26.0 | 36   | 127.8 | 46.5 | 96   | 184.2 | 67.0 | 56   | 240.6 | 87.6  | 116  | 298.1 | 107.4 |
| 17   | 16.0 | 05.8 | 77   | 72.4  | 26.3 | 37   | 128.7 | 46.9 | 97   | 185.1 | 67.4 | 57   | 241.5 | 87.9  | 117  | 299.1 | 107.7 |
| 18   | 16.9 | 06.2 | 78   | 73.3  | 26.7 | 38   | 129.7 | 47.2 | 98   | 186.1 | 67.7 | 58   | 242.4 | 88.2  | 118  | 300.1 | 108.0 |
| 19   | 17.9 | 06.5 | 79   | 74.2  | 27.0 | 39   | 130.6 | 47.5 | 99   | 187.0 | 68.1 | 59   | 243.4 | 88.6  | 119  | 301.1 | 108.3 |
| 20   | 18.8 | 06.8 | 80   | 75.2  | 27.4 | 40   | 131.6 | 47.9 | 200  | 187.9 | 68.4 | 60   | 244.3 | 88.9  | 120  | 302.1 | 108.6 |
| 21   | 19.7 | 07.2 | 81   | 76.1  | 27.7 | 141  | 132.5 | 48.2 | 201  | 188.9 | 68.7 | 261  | 245.3 | 89.3  | 121  | 303.1 | 108.9 |
| 22   | 20.7 | 07.5 | 82   | 77.1  | 28.0 | 42   | 133.4 | 48.6 | 02   | 189.8 | 69.1 | 62   | 246.2 | 89.6  | 122  | 304.1 | 109.2 |
| 23   | 21.6 | 07.9 | 83   | 78.0  | 28.4 | 43   | 134.4 | 48.9 | 03   | 190.8 | 69.4 | 63   | 247.1 | 89.9  | 123  | 305.1 | 109.5 |
| 24   | 22.6 | 08.2 | 84   | 78.9  | 28.7 | 44   | 135.3 | 49.2 | 04   | 191.7 | 69.8 | 64   | 248.1 | 90.3  | 124  | 306.1 | 109.8 |
| 25   | 23.5 | 08.6 | 85   | 79.9  | 29.1 | 45   | 136.3 | 49.6 | 05   | 192.6 | 70.1 | 65   | 249.0 | 90.6  | 125  | 307.1 | 110.1 |
| 26   | 24.4 | 08.9 | 86   | 80.8  | 29.4 | 46   | 137.2 | 49.9 | 06   | 193.6 | 70.5 | 66   | 250.0 | 91.0  | 126  | 308.1 | 110.4 |
| 27   | 25.4 | 09.2 | 87   | 81.8  | 29.8 | 47   | 138.1 | 50.3 | 07   | 194.5 | 70.8 | 67   | 251.0 | 91.3  | 127  | 309.1 | 110.7 |
| 28   | 26.3 | 09.6 | 88   | 82.7  | 30.1 | 48   | 139.1 | 50.6 | 08   | 195.5 | 71.1 | 68   | 252.0 | 91.7  | 128  | 310.1 | 111.0 |
| 29   | 27.3 | 09.9 | 89   | 83.6  | 30.4 | 49   | 140.0 | 51.0 | 09   | 196.4 | 71.5 | 69   | 252.8 | 92.0  | 129  | 311.1 | 111.3 |
| 30   | 28.2 | 10.3 | 90   | 84.6  | 30.8 | 50   | 141.0 | 51.3 | 10   | 197.3 | 71.8 | 70   | 253.7 | 92.3  | 130  | 312.1 | 111.6 |
| 31   | 29.1 | 10.6 | 91   | 85.5  | 31.1 | 151  | 141.9 | 51.6 | 211  | 198.3 | 72.2 | 271  | 254.7 | 92.7  | 131  | 313.1 | 111.9 |
| 32   | 30.1 | 10.9 | 92   | 86.5  | 31.5 | 52   | 142.8 | 52.0 | 12   | 199.2 | 72.5 | 72   | 255.6 | 93.0  | 132  | 314.1 | 112.2 |
| 33   | 31.0 | 11.3 | 93   | 87.4  | 31.8 | 53   | 143.8 | 52.3 | 13   | 200.2 | 72.8 | 73   | 256.5 | 93.3  | 133  | 315.1 | 112.5 |
| 34   | 31.9 | 11.6 | 94   | 88.3  | 32.1 | 54   | 144.7 | 52.7 | 14   | 201.1 | 73.2 | 74   | 257.5 | 93.7  | 134  | 316.1 | 112.8 |
| 35   | 32.9 | 12.0 | 95   | 89.3  | 32.5 | 55   | 145.7 | 53.0 | 15   | 202.0 | 73.5 | 75   | 258.4 | 94.0  | 135  | 317.1 | 113.1 |
| 36   | 33.8 | 12.3 | 96   | 90.2  | 32.8 | 56   | 146.6 | 53.4 | 16   | 203.0 | 73.9 | 76   | 259.4 | 94.4  | 136  | 318.1 | 113.4 |
| 37   | 34.8 | 12.7 | 97   | 91.2  | 33.2 | 57   | 147.5 | 53.7 | 17   | 203.9 | 74.2 | 77   | 260.3 | 94.7  | 137  | 319.1 | 113.7 |
| 38   | 35.7 | 13.0 | 98   | 92.1  | 33.5 | 58   | 148.5 | 54.0 | 18   | 204.9 | 74.6 | 78   | 261.2 | 95.1  | 138  | 320.1 | 114.0 |
| 39   | 36.6 | 13.3 | 99   | 93.0  | 33.9 | 59   | 149.4 | 54.4 | 19   | 205.8 | 74.9 | 79   | 262.1 | 95.4  | 139  | 321.1 | 114.3 |
| 40   | 37.6 | 13.7 | 100  | 94.0  | 34.2 | 60   | 150.4 | 54.7 | 20   | 206.7 | 75.2 | 80   | 263.1 | 95.8  | 140  | 322.1 | 114.6 |
| 41   | 38.5 | 14.0 | 101  | 94.9  | 34.5 | 161  | 151.3 | 55.1 | 221  | 207.7 | 75.6 | 281  | 264.1 | 96.1  | 141  | 323.1 | 114.9 |
| 42   | 39.5 | 14.4 | 02   | 95.8  | 34.9 | 62   | 152.2 | 55.4 | 22   | 208.6 | 75.9 | 82   | 265.0 | 96.4  | 142  | 324.1 | 115.2 |
| 43   | 40.4 | 14.7 | 03   | 96.8  | 35.2 | 63   | 153.2 | 55.7 | 23   | 209.6 | 76.3 | 83   | 265.9 | 96.8  | 143  | 325.1 | 115.5 |
| 44   | 41.3 | 15.0 | 04   | 97.7  | 35.6 | 64   | 154.1 | 56.1 | 24   | 210.5 | 76.6 | 84   | 266.9 | 97.1  | 144  | 326.1 | 115.8 |
| 45   | 42.3 | 15.4 | 05   | 98.7  | 35.9 | 65   | 155.1 | 56.4 | 25   | 211.4 | 77.0 | 85   | 267.8 | 97.5  | 145  | 327.1 | 116.1 |
| 46   | 43.2 | 15.7 | 06   | 99.6  | 36.3 | 66   | 156.0 | 56.8 | 26   | 212.4 | 77.3 | 86   | 268.8 | 97.8  | 146  | 328.1 | 116.4 |
| 47   | 44.2 | 16.1 | 07   | 100.5 | 36.6 | 67   | 156.9 | 57.1 | 27   | 213.3 | 77.6 | 87   | 269.7 | 98.2  | 147  | 329.1 | 116.7 |
| 48   | 45.1 | 16.4 | 08   | 101.5 | 36.9 | 68   | 157.9 | 57.5 | 28   | 214.3 | 78.0 | 88   | 270.6 | 98.5  | 148  | 330.1 | 117.0 |
| 49   | 46.0 | 16.8 | 09   | 102.4 | 37.3 | 69   | 158.8 | 57.8 | 29   | 215.2 | 78.3 | 89   | 271.6 | 98.9  | 149  | 331.1 | 117.3 |
| 50   | 47.0 | 17.1 | 10   | 103.4 | 37.6 | 70   | 159.7 | 58.1 | 30   | 216.1 | 78.7 | 90   | 272.5 | 99.2  | 150  | 332.1 | 117.6 |
| 51   | 47.9 | 17.4 | 111  | 104.3 | 38.0 | 171  | 160.7 | 58.5 | 231  | 217.1 | 79.0 | 291  | 273.5 | 99.6  | 151  | 333.1 | 117.9 |
| 52   | 48.9 | 17.8 | 12   | 105.2 | 38.3 | 72   | 161.6 | 58.8 | 32   | 218.0 | 79.3 | 92   | 274.4 | 99.9  | 152  | 334.1 | 118.2 |
| 53   | 49.8 | 18.1 | 13   | 106.2 | 38.6 | 73   | 162.6 | 59.2 | 33   | 219.0 | 79.7 | 93   | 275.3 | 100.3 | 153  | 335.1 | 118.5 |
| 54   | 50.7 | 18.5 | 14   | 107.1 | 39.0 | 74   | 163.5 | 59.5 | 34   | 219.9 | 80.0 | 94   | 276.3 | 100.6 | 154  | 336.1 | 118.8 |
| 55   | 51.7 | 18.8 | 15   | 108.1 | 39.3 | 75   | 164.4 | 59.9 | 35   | 220.8 | 80.4 | 95   | 277.2 | 101.0 | 155  | 337.1 | 119.1 |
| 56   | 52.6 | 19.2 | 16   | 109.0 | 39.7 | 76   | 165.4 | 60.2 | 36   | 221.8 | 80.7 | 96   | 278.2 | 101.3 | 156  | 338.1 | 119.4 |
| 57   | 53.6 | 19.5 | 17   | 109.9 | 40.0 | 77   | 166.3 | 60.5 | 37   | 222.7 | 81.1 | 97   | 279.1 | 101.7 | 157  | 339.1 | 119.7 |
| 58   | 54.5 | 19.8 | 18   | 110.9 | 40.4 | 78   | 167.3 | 60.9 | 38   | 223.6 | 81.4 | 98   | 280.1 | 102.0 | 158  | 340.1 | 120.0 |
| 59   | 55.4 | 20.2 | 19   | 111.8 | 40.7 | 79   | 168.2 | 61.2 | 39   | 224.6 | 81.7 | 99   | 281.0 | 102.4 | 159  | 341.1 | 120.3 |
| 60   | 56.4 | 20.5 | 120  | 112.8 | 41.0 | 180  | 169.1 | 61.6 | 40   | 225.5 | 82.1 | 300  | 282.0 | 102.7 | 160  | 342.1 | 120.6 |

for 70 Degrees.

TABLE III. Difference of Latitude and Departure for 21 Degrees.

| Dist | Lat  | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep   |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|-------|
| 1    | 00.9 | 00.4 | 61   | 56.9  | 21.9 | 121  | 113.0 | 43.4 | 181  | 169.0 | 64.9 | 241  | 225.0 | 86.4  |
| 2    | 01.9 | 00.7 | 62   | 57.9  | 22.2 | 122  | 113.9 | 43.7 | 82   | 169.9 | 65.2 | 42   | 225.9 | 86.7  |
| 3    | 02.8 | 01.1 | 63   | 58.8  | 22.6 | 23   | 114.9 | 44.1 | 83   | 170.9 | 65.6 | 43   | 226.9 | 87.1  |
| 4    | 03.7 | 01.4 | 64   | 59.7  | 22.9 | 24   | 115.8 | 44.4 | 84   | 171.8 | 65.6 | 44   | 227.8 | 87.4  |
| 5    | 04.7 | 01.8 | 65   | 60.7  | 23.3 | 25   | 116.7 | 44.8 | 85   | 172.7 | 66.3 | 45   | 228.7 | 87.8  |
| 6    | 05.6 | 02.2 | 66   | 61.6  | 23.7 | 26   | 117.7 | 45.2 | 86   | 173.7 | 66.7 | 46   | 229.7 | 88.2  |
| 7    | 06.5 | 02.5 | 67   | 62.5  | 24.0 | 27   | 118.6 | 45.5 | 87   | 174.6 | 67.0 | 47   | 230.6 | 88.5  |
| 8    | 07.5 | 02.9 | 68   | 63.5  | 24.4 | 28   | 119.5 | 45.9 | 88   | 175.5 | 67.4 | 48   | 231.5 | 88.9  |
| 9    | 08.4 | 03.2 | 69   | 64.4  | 24.7 | 29   | 120.5 | 46.2 | 89   | 176.5 | 67.7 | 49   | 232.5 | 89.2  |
| 10   | 09.3 | 03.6 | 70   | 65.3  | 25.1 | 30   | 121.4 | 46.6 | 90   | 177.4 | 68.1 | 50   | 233.4 | 89.6  |
| 11   | 10.3 | 03.9 | 71   | 66.3  | 25.4 | 131  | 122.3 | 47.0 | 91   | 178.3 | 68.5 | 251  | 234.3 | 90.0  |
| 12   | 11.2 | 04.3 | 72   | 67.2  | 25.8 | 32   | 123.3 | 47.3 | 92   | 179.3 | 68.8 | 52   | 235.3 | 90.3  |
| 13   | 12.1 | 04.6 | 73   | 68.1  | 26.2 | 33   | 124.2 | 47.7 | 93   | 180.2 | 69.2 | 53   | 236.2 | 90.7  |
| 14   | 13.1 | 05.0 | 74   | 69.0  | 26.5 | 34   | 125.1 | 48.0 | 94   | 181.1 | 69.5 | 54   | 237.1 | 91.0  |
| 15   | 14.0 | 05.4 | 75   | 70.0  | 26.9 | 35   | 126.1 | 48.4 | 95   | 182.1 | 69.9 | 55   | 238.1 | 91.4  |
| 16   | 14.9 | 05.7 | 76   | 70.9  | 27.2 | 36   | 127.0 | 48.7 | 96   | 183.0 | 70.2 | 56   | 239.0 | 91.8  |
| 17   | 15.9 | 06.1 | 77   | 71.9  | 27.6 | 37   | 127.9 | 49.1 | 97   | 183.9 | 70.6 | 57   | 239.9 | 92.1  |
| 18   | 16.8 | 06.5 | 78   | 72.8  | 28.0 | 38   | 128.9 | 49.5 | 98   | 184.9 | 71.0 | 58   | 240.9 | 92.5  |
| 19   | 17.7 | 06.8 | 79   | 73.7  | 28.3 | 39   | 129.8 | 49.8 | 99   | 185.8 | 71.3 | 59   | 241.8 | 92.8  |
| 20   | 18.7 | 07.2 | 80   | 74.7  | 28.7 | 40   | 130.7 | 50.2 | 200  | 186.7 | 71.7 | 60   | 242.7 | 93.2  |
| 21   | 19.6 | 07.5 | 81   | 75.6  | 29.0 | 141  | 131.7 | 50.5 | 201  | 187.6 | 72.0 | 261  | 243.7 | 93.5  |
| 22   | 20.5 | 07.9 | 82   | 76.5  | 29.4 | 42   | 132.6 | 50.9 | 02   | 188.6 | 72.4 | 62   | 244.6 | 93.9  |
| 23   | 21.5 | 08.2 | 83   | 77.5  | 29.7 | 43   | 133.5 | 51.3 | 03   | 189.5 | 72.8 | 63   | 245.5 | 94.3  |
| 24   | 22.4 | 08.6 | 84   | 78.4  | 30.1 | 44   | 134.5 | 51.6 | 04   | 190.4 | 73.1 | 64   | 246.5 | 94.6  |
| 25   | 23.3 | 09.0 | 85   | 79.3  | 30.5 | 45   | 135.4 | 52.0 | 05   | 191.4 | 73.5 | 65   | 247.4 | 95.0  |
| 26   | 24.3 | 09.3 | 86   | 80.3  | 30.8 | 46   | 136.3 | 52.3 | 06   | 192.3 | 73.8 | 66   | 248.3 | 95.3  |
| 27   | 25.2 | 09.7 | 87   | 81.2  | 31.2 | 47   | 137.3 | 52.7 | 07   | 193.2 | 74.2 | 67   | 249.3 | 95.7  |
| 28   | 26.1 | 10.0 | 88   | 82.1  | 31.5 | 48   | 138.2 | 53.0 | 08   | 194.2 | 74.5 | 68   | 250.2 | 96.1  |
| 29   | 27.1 | 10.4 | 89   | 83.1  | 31.9 | 49   | 139.1 | 53.4 | 09   | 195.1 | 74.9 | 69   | 251.1 | 96.4  |
| 30   | 28.0 | 10.8 | 90   | 84.0  | 32.3 | 50   | 140.1 | 53.8 | 10   | 196.0 | 75.3 | 70   | 252.1 | 96.8  |
| 31   | 28.9 | 11.1 | 91   | 84.9  | 32.6 | 151  | 141.0 | 54.1 | 211  | 197.0 | 75.6 | 271  | 253.0 | 97.1  |
| 32   | 29.9 | 11.5 | 92   | 85.9  | 33.0 | 52   | 141.9 | 54.5 | 12   | 197.9 | 76.0 | 72   | 253.9 | 97.5  |
| 33   | 30.8 | 11.8 | 93   | 86.8  | 33.3 | 53   | 142.9 | 54.8 | 13   | 198.8 | 76.3 | 73   | 254.9 | 97.8  |
| 34   | 31.7 | 12.2 | 94   | 87.7  | 33.7 | 54   | 143.8 | 55.2 | 14   | 199.8 | 76.7 | 74   | 255.8 | 98.2  |
| 35   | 32.7 | 12.5 | 95   | 88.7  | 34.0 | 55   | 144.7 | 55.6 | 15   | 200.7 | 77.1 | 75   | 256.7 | 98.6  |
| 36   | 33.6 | 12.9 | 96   | 89.6  | 34.4 | 56   | 145.7 | 55.9 | 16   | 201.6 | 77.4 | 76   | 257.7 | 98.9  |
| 37   | 34.5 | 13.3 | 97   | 90.5  | 34.8 | 57   | 146.6 | 56.3 | 17   | 202.6 | 77.8 | 77   | 258.6 | 99.3  |
| 38   | 35.5 | 13.6 | 98   | 91.5  | 35.1 | 58   | 147.5 | 56.6 | 18   | 203.5 | 78.1 | 78   | 259.5 | 99.6  |
| 39   | 36.4 | 14.0 | 99   | 92.4  | 35.5 | 59   | 148.5 | 57.0 | 19   | 204.4 | 78.5 | 79   | 260.5 | 100.0 |
| 40   | 37.3 | 14.3 | 100  | 93.4  | 35.8 | 60   | 149.4 | 57.3 | 20   | 205.4 | 78.8 | 80   | 261.4 | 100.4 |
| 41   | 38.3 | 14.7 | 101  | 94.3  | 36.2 | 161  | 150.3 | 57.7 | 221  | 206.3 | 79.2 | 281  | 262.3 | 100.7 |
| 42   | 39.2 | 15.1 | 02   | 95.3  | 36.6 | 62   | 151.3 | 58.1 | 22   | 207.2 | 79.6 | 82   | 263.3 | 101.1 |
| 43   | 40.1 | 15.4 | 03   | 96.2  | 36.9 | 63   | 152.2 | 58.4 | 23   | 208.2 | 79.9 | 83   | 264.2 | 101.4 |
| 44   | 41.1 | 15.8 | 04   | 97.1  | 37.3 | 64   | 153.1 | 58.8 | 24   | 209.1 | 80.3 | 84   | 265.1 | 101.8 |
| 45   | 42.0 | 16.1 | 05   | 98.1  | 37.6 | 65   | 154.1 | 59.1 | 25   | 210.0 | 80.6 | 85   | 266.1 | 102.1 |
| 46   | 42.9 | 16.5 | 06   | 99.0  | 38.0 | 66   | 155.0 | 59.5 | 26   | 211.0 | 81.0 | 86   | 267.0 | 102.5 |
| 47   | 43.9 | 16.8 | 07   | 99.9  | 38.3 | 67   | 155.9 | 59.9 | 27   | 211.9 | 81.4 | 87   | 267.9 | 102.9 |
| 48   | 44.8 | 17.2 | 08   | 100.9 | 38.7 | 68   | 156.9 | 60.2 | 28   | 212.8 | 81.7 | 88   | 268.9 | 103.2 |
| 49   | 45.7 | 17.6 | 09   | 101.8 | 39.1 | 69   | 157.8 | 60.6 | 29   | 213.8 | 82.1 | 89   | 269.8 | 103.6 |
| 50   | 46.7 | 17.9 | 10   | 102.7 | 39.4 | 70   | 158.7 | 60.9 | 30   | 214.7 | 82.4 | 90   | 270.7 | 103.9 |
| 51   | 47.6 | 18.3 | 111  | 103.7 | 39.8 | 171  | 159.7 | 61.3 | 231  | 215.6 | 82.8 | 291  | 271.7 | 104.3 |
| 52   | 48.5 | 18.6 | 12   | 104.6 | 40.1 | 72   | 160.6 | 61.6 | 32   | 216.6 | 83.1 | 92   | 272.6 | 104.7 |
| 53   | 49.5 | 19.0 | 13   | 105.5 | 40.5 | 73   | 161.5 | 62.0 | 33   | 217.5 | 83.5 | 93   | 273.5 | 105.0 |
| 54   | 50.4 | 19.4 | 14   | 106.5 | 40.9 | 74   | 162.5 | 62.4 | 34   | 218.4 | 83.9 | 94   | 274.5 | 105.4 |
| 55   | 51.3 | 19.7 | 15   | 107.4 | 41.2 | 75   | 163.4 | 62.7 | 35   | 219.4 | 84.2 | 95   | 275.4 | 105.7 |
| 56   | 52.3 | 20.1 | 16   | 108.3 | 41.6 | 76   | 164.3 | 63.1 | 36   | 220.3 | 84.6 | 96   | 276.3 | 106.1 |
| 57   | 53.2 | 20.4 | 17   | 109.3 | 41.9 | 77   | 165.3 | 63.4 | 37   | 221.2 | 84.9 | 97   | 277.3 | 106.4 |
| 58   | 54.1 | 20.8 | 18   | 110.2 | 42.3 | 78   | 166.2 | 63.8 | 38   | 222.2 | 85.3 | 98   | 278.2 | 106.8 |
| 59   | 55.1 | 21.1 | 19   | 111.1 | 42.6 | 79   | 167.1 | 64.2 | 39   | 223.1 | 85.7 | 99   | 279.1 | 107.2 |
| 60   | 56.0 | 21.5 | 20   | 112.1 | 43.0 | 180  | 168.1 | 64.5 | 240  | 224.1 | 86.0 | 300  | 280.1 | 107.5 |
| Dist | Dep  | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat   |



TABLE III. Difference of Latitude and Departure for 22 Degrees

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep   | Dist | Lat.  | Dep   |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|
| 1    | 00.9 | 00.4 | 61   | 56.6  | 22.9 | 121  | 112.2 | 45.3 | 181  | 167.8 | 67.8 | 241  | 223.3 | 90.3  | 301  | 278.8 | 117.8 |
| 2    | 01.9 | 00.7 | 62   | 57.5  | 23.2 | 22   | 113.1 | 45.7 | 82   | 168.8 | 68.2 | 42   | 224.4 | 90.7  | 102  | 279.9 | 118.2 |
| 3    | 02.8 | 01.1 | 63   | 58.4  | 23.6 | 23   | 114.0 | 46.1 | 83   | 169.7 | 68.6 | 43   | 225.3 | 91.0  | 103  | 280.9 | 118.6 |
| 4    | 03.7 | 01.5 | 64   | 59.3  | 24.0 | 24   | 115.0 | 46.5 | 84   | 170.6 | 68.9 | 44   | 226.2 | 91.4  | 104  | 281.9 | 119.0 |
| 5    | 04.6 | 01.9 | 65   | 60.3  | 24.3 | 25   | 115.9 | 46.8 | 85   | 171.5 | 69.3 | 45   | 227.2 | 91.8  | 105  | 282.9 | 119.4 |
| 6    | 05.6 | 02.2 | 66   | 61.2  | 24.7 | 26   | 116.8 | 47.2 | 86   | 172.5 | 69.7 | 46   | 228.1 | 92.2  | 106  | 283.9 | 119.8 |
| 7    | 06.5 | 02.6 | 67   | 62.1  | 25.1 | 27   | 117.8 | 47.6 | 87   | 173.4 | 70.1 | 47   | 229.0 | 92.5  | 107  | 284.9 | 120.2 |
| 8    | 07.4 | 03.0 | 68   | 63.0  | 25.5 | 28   | 118.7 | 47.9 | 88   | 174.3 | 70.4 | 48   | 229.9 | 92.9  | 108  | 285.9 | 120.6 |
| 9    | 08.3 | 03.4 | 69   | 64.0  | 25.8 | 29   | 119.6 | 48.3 | 89   | 175.2 | 70.8 | 49   | 230.9 | 93.3  | 109  | 286.9 | 121.0 |
| 10   | 09.3 | 03.7 | 70   | 64.9  | 26.2 | 30   | 120.5 | 48.7 | 90   | 176.2 | 71.2 | 50   | 231.8 | 93.7  | 110  | 287.9 | 121.4 |
| 11   | 10.2 | 04.1 | 71   | 65.8  | 26.6 | 131  | 121.5 | 49.1 | 191  | 177.1 | 71.5 | 251  | 232.7 | 94.0  | 311  | 288.9 | 121.8 |
| 12   | 11.1 | 04.5 | 72   | 66.8  | 27.0 | 32   | 122.4 | 49.4 | 92   | 178.0 | 71.9 | 52   | 233.7 | 94.4  | 122  | 289.9 | 122.2 |
| 13   | 12.1 | 04.9 | 73   | 67.7  | 27.3 | 33   | 123.3 | 49.8 | 93   | 178.9 | 72.3 | 53   | 234.6 | 94.8  | 123  | 290.9 | 122.6 |
| 14   | 13.0 | 05.2 | 74   | 68.6  | 27.7 | 34   | 124.2 | 50.2 | 94   | 179.8 | 72.7 | 54   | 235.5 | 95.2  | 124  | 291.9 | 123.0 |
| 15   | 13.9 | 05.6 | 75   | 69.5  | 28.1 | 35   | 125.2 | 50.6 | 95   | 180.8 | 73.0 | 55   | 236.4 | 95.5  | 125  | 292.9 | 123.4 |
| 16   | 14.8 | 06.0 | 76   | 70.5  | 28.5 | 36   | 126.1 | 50.9 | 96   | 181.7 | 73.4 | 56   | 237.4 | 95.9  | 126  | 293.9 | 123.8 |
| 17   | 15.8 | 06.4 | 77   | 71.4  | 28.8 | 37   | 127.0 | 51.3 | 97   | 182.7 | 73.8 | 57   | 238.3 | 96.3  | 127  | 294.9 | 124.2 |
| 18   | 16.7 | 06.7 | 78   | 72.3  | 29.2 | 38   | 128.0 | 51.7 | 98   | 183.6 | 74.2 | 58   | 239.2 | 96.6  | 128  | 295.9 | 124.6 |
| 19   | 17.6 | 07.1 | 79   | 73.2  | 29.6 | 39   | 128.9 | 52.1 | 99   | 184.5 | 74.5 | 59   | 240.1 | 97.0  | 129  | 296.9 | 125.0 |
| 20   | 18.5 | 07.5 | 80   | 74.2  | 30.0 | 40   | 129.8 | 52.4 | 200  | 185.4 | 74.9 | 60   | 241.1 | 97.4  | 130  | 297.9 | 125.4 |
| 21   | 19.5 | 07.9 | 81   | 75.1  | 30.3 | 141  | 130.7 | 52.8 | 201  | 186.4 | 75.3 | 261  | 242.0 | 97.8  | 321  | 298.9 | 125.8 |
| 22   | 20.4 | 08.2 | 82   | 76.0  | 30.7 | 42   | 131.7 | 53.2 | 02   | 187.3 | 75.7 | 62   | 242.9 | 98.1  | 222  | 299.9 | 126.2 |
| 23   | 21.3 | 08.6 | 83   | 77.0  | 31.1 | 43   | 132.6 | 53.6 | 03   | 188.2 | 76.0 | 63   | 243.9 | 98.5  | 223  | 300.9 | 126.6 |
| 24   | 22.3 | 09.0 | 84   | 77.9  | 31.5 | 44   | 133.5 | 53.9 | 04   | 189.1 | 76.4 | 64   | 244.8 | 98.9  | 224  | 301.9 | 127.0 |
| 25   | 23.2 | 09.4 | 85   | 78.8  | 31.8 | 45   | 134.4 | 54.3 | 05   | 190.1 | 76.8 | 65   | 245.7 | 99.3  | 225  | 302.9 | 127.4 |
| 26   | 24.1 | 09.7 | 86   | 79.7  | 32.2 | 46   | 135.4 | 54.7 | 06   | 191.0 | 77.2 | 66   | 246.6 | 99.6  | 226  | 303.9 | 127.8 |
| 27   | 25.0 | 10.1 | 87   | 80.7  | 32.6 | 47   | 136.3 | 55.1 | 07   | 191.9 | 77.5 | 67   | 247.6 | 100.0 | 227  | 304.9 | 128.2 |
| 28   | 26.0 | 10.5 | 88   | 81.6  | 33.0 | 48   | 137.2 | 55.4 | 08   | 192.9 | 77.9 | 68   | 248.5 | 100.4 | 228  | 305.9 | 128.6 |
| 29   | 26.9 | 10.9 | 89   | 82.5  | 33.3 | 49   | 138.2 | 55.8 | 09   | 193.8 | 78.3 | 69   | 249.4 | 100.8 | 229  | 306.9 | 129.0 |
| 30   | 27.8 | 11.2 | 90   | 83.4  | 33.7 | 50   | 139.1 | 56.2 | 10   | 194.7 | 78.7 | 70   | 250.3 | 101.1 | 230  | 307.9 | 129.4 |
| 31   | 28.7 | 11.6 | 91   | 84.4  | 34.1 | 151  | 140.0 | 56.6 | 211  | 195.6 | 79.0 | 271  | 251.3 | 101.5 | 331  | 308.9 | 129.8 |
| 32   | 29.7 | 12.0 | 92   | 85.3  | 34.5 | 52   | 140.9 | 55.9 | 12   | 196.6 | 79.4 | 72   | 252.2 | 101.9 | 232  | 309.9 | 130.2 |
| 33   | 30.6 | 12.4 | 93   | 86.2  | 34.8 | 53   | 141.9 | 57.3 | 13   | 197.5 | 79.8 | 73   | 253.1 | 102.3 | 233  | 310.9 | 130.6 |
| 34   | 31.5 | 12.7 | 94   | 87.2  | 35.2 | 54   | 142.8 | 57.7 | 14   | 198.4 | 80.2 | 74   | 254.1 | 102.6 | 234  | 311.9 | 131.0 |
| 35   | 32.5 | 13.1 | 95   | 88.1  | 35.6 | 55   | 143.7 | 58.1 | 15   | 199.3 | 80.5 | 75   | 255.0 | 103.0 | 235  | 312.9 | 131.4 |
| 36   | 33.4 | 13.5 | 96   | 89.0  | 36.0 | 56   | 144.6 | 58.4 | 16   | 200.3 | 80.9 | 76   | 255.9 | 103.4 | 236  | 313.9 | 131.8 |
| 37   | 34.3 | 13.9 | 97   | 89.9  | 36.3 | 57   | 145.6 | 58.8 | 17   | 201.2 | 81.3 | 77   | 256.8 | 103.8 | 237  | 314.9 | 132.2 |
| 38   | 35.2 | 14.2 | 98   | 90.9  | 36.7 | 58   | 146.5 | 59.2 | 18   | 202.1 | 81.7 | 78   | 257.7 | 104.1 | 238  | 315.9 | 132.6 |
| 39   | 36.2 | 14.6 | 99   | 91.8  | 37.1 | 59   | 147.4 | 59.6 | 19   | 203.1 | 82.0 | 79   | 258.7 | 104.5 | 239  | 316.9 | 133.0 |
| 40   | 37.1 | 15.0 | 100  | 92.7  | 37.5 | 60   | 148.4 | 59.9 | 20   | 204.0 | 82.4 | 80   | 259.6 | 104.9 | 240  | 317.9 | 133.4 |
| 41   | 38.0 | 15.4 | 101  | 93.6  | 37.8 | 161  | 149.3 | 60.3 | 221  | 204.9 | 82.8 | 281  | 260.5 | 105.3 | 341  | 318.9 | 133.8 |
| 42   | 38.9 | 15.7 | 02   | 94.6  | 38.2 | 62   | 150.2 | 60.7 | 22   | 205.8 | 83.2 | 82   | 261.5 | 105.6 | 242  | 319.9 | 134.2 |
| 43   | 39.9 | 16.1 | 03   | 95.5  | 38.6 | 63   | 151.1 | 61.1 | 23   | 206.7 | 83.5 | 83   | 262.4 | 106.0 | 243  | 320.9 | 134.6 |
| 44   | 40.8 | 16.5 | 04   | 96.4  | 39.0 | 64   | 152.1 | 61.4 | 24   | 207.7 | 83.9 | 84   | 263.3 | 106.4 | 244  | 321.9 | 135.0 |
| 45   | 41.7 | 16.9 | 05   | 97.4  | 39.3 | 65   | 153.0 | 61.8 | 25   | 208.6 | 84.3 | 85   | 264.3 | 106.8 | 245  | 322.9 | 135.4 |
| 46   | 42.7 | 17.2 | 06   | 98.3  | 39.7 | 66   | 153.9 | 62.2 | 26   | 209.5 | 84.7 | 86   | 265.2 | 107.1 | 246  | 323.9 | 135.8 |
| 47   | 43.6 | 17.6 | 07   | 99.2  | 40.1 | 67   | 154.8 | 62.6 | 27   | 210.5 | 85.0 | 87   | 266.1 | 107.5 | 247  | 324.9 | 136.2 |
| 48   | 44.5 | 18.0 | 08   | 100.1 | 40.5 | 68   | 155.8 | 62.9 | 28   | 211.4 | 85.4 | 88   | 267.0 | 107.9 | 248  | 325.9 | 136.6 |
| 49   | 45.4 | 18.4 | 09   | 101.1 | 40.8 | 69   | 156.7 | 63.3 | 29   | 212.3 | 85.8 | 89   | 268.0 | 108.3 | 249  | 326.9 | 137.0 |
| 50   | 46.4 | 18.7 | 10   | 102.0 | 41.2 | 70   | 157.6 | 63.7 | 30   | 213.3 | 86.2 | 90   | 268.9 | 108.6 | 250  | 327.9 | 137.4 |
| 51   | 47.3 | 19.1 | 111  | 102.9 | 41.6 | 171  | 158.6 | 64.1 | 231  | 214.2 | 86.5 | 291  | 269.8 | 109.0 | 351  | 328.9 | 137.8 |
| 52   | 48.2 | 19.5 | 12   | 103.8 | 42.0 | 72   | 159.5 | 64.4 | 32   | 215.1 | 86.9 | 92   | 270.7 | 109.4 | 252  | 329.9 | 138.2 |
| 53   | 49.1 | 19.9 | 13   | 104.8 | 42.3 | 73   | 160.4 | 64.8 | 33   | 216.0 | 87.3 | 93   | 271.7 | 109.8 | 253  | 330.9 | 138.6 |
| 54   | 50.1 | 20.2 | 14   | 105.7 | 42.7 | 74   | 161.3 | 65.2 | 34   | 217.0 | 87.7 | 94   | 272.6 | 110.1 | 254  | 331.9 | 139.0 |
| 55   | 51.0 | 20.6 | 15   | 106.6 | 43.1 | 75   | 162.3 | 65.6 | 35   | 217.9 | 88.0 | 95   | 273.5 | 110.5 | 255  | 332.9 | 139.4 |
| 56   | 51.9 | 21.0 | 16   | 107.6 | 43.5 | 76   | 163.2 | 65.9 | 36   | 218.8 | 88.4 | 96   | 274.5 | 110.9 | 256  | 333.9 | 139.8 |
| 57   | 52.9 | 21.4 | 17   | 108.5 | 43.8 | 77   | 164.1 | 66.3 | 37   | 219.7 | 88.8 | 97   | 275.4 | 111.3 | 257  | 334.9 | 140.2 |
| 58   | 53.8 | 21.7 | 18   | 109.4 | 44.2 | 78   | 165.0 | 66.7 | 38   | 220.7 | 89.2 | 98   | 276.3 | 111.6 | 258  | 335.9 | 140.6 |
| 59   | 54.7 | 22.1 | 19   | 110.3 | 44.6 | 79   | 166.0 | 67.1 | 39   | 221.6 | 89.5 | 99   | 277.2 | 112.0 | 259  | 336.9 | 141.0 |
| 60   | 55.6 | 22.5 | 120  | 111.3 | 45.0 | 180  | 166.9 | 67.4 | 240  | 222.5 | 89.9 | 300  | 278.2 | 112.4 | 260  | 337.9 | 141.4 |
| Dist | Dep  | Lat  | Dist | Dep.  | Lat  | Dist | Dep   | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat   | Dist | Dep.  | Lat   |

for 68 Degrees.

TABLE III. Difference of Latitude and Departure for 23 Degrees.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep   |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|-------|
| 1    | 00.9 | 00.4 | 61   | 56.1  | 23.8 | 121  | 111.4 | 47.3 | 181  | 166.6 | 70.7 | 241  | 221.8 | 94.1  |
| 2    | 01.8 | 00.8 | 62   | 57.1  | 24.2 | 122  | 112.3 | 47.7 | 182  | 167.5 | 71.1 | 242  | 222.8 | 94.5  |
| 3    | 02.8 | 01.2 | 63   | 58.0  | 24.6 | 123  | 113.2 | 48.1 | 183  | 168.5 | 71.5 | 243  | 223.7 | 94.9  |
| 4    | 03.7 | 01.6 | 64   | 58.9  | 25.0 | 124  | 114.1 | 48.4 | 184  | 169.4 | 71.9 | 244  | 224.6 | 95.3  |
| 5    | 04.6 | 02.0 | 65   | 59.8  | 25.4 | 125  | 115.1 | 48.8 | 185  | 170.3 | 72.3 | 245  | 225.5 | 95.7  |
| 6    | 05.5 | 02.3 | 66   | 60.8  | 25.8 | 126  | 116.0 | 49.2 | 186  | 171.2 | 72.7 | 246  | 226.4 | 96.1  |
| 7    | 06.4 | 02.7 | 67   | 61.7  | 26.2 | 127  | 116.9 | 49.6 | 187  | 172.2 | 73.1 | 247  | 227.4 | 96.5  |
| 8    | 07.4 | 03.1 | 68   | 62.6  | 26.6 | 128  | 117.8 | 50.0 | 188  | 173.1 | 73.5 | 248  | 228.3 | 96.9  |
| 9    | 08.3 | 03.5 | 69   | 63.5  | 27.0 | 129  | 118.7 | 50.4 | 189  | 174.0 | 73.8 | 249  | 229.2 | 97.3  |
| 10   | 09.2 | 03.9 | 70   | 64.4  | 27.3 | 130  | 119.7 | 50.8 | 190  | 174.9 | 74.2 | 250  | 230.1 | 97.7  |
| 11   | 10.1 | 04.3 | 71   | 65.4  | 27.7 | 131  | 120.6 | 51.2 | 191  | 175.8 | 74.6 | 251  | 231.0 | 98.1  |
| 12   | 11.0 | 04.7 | 72   | 66.3  | 28.1 | 132  | 121.5 | 51.6 | 192  | 176.7 | 75.0 | 252  | 232.0 | 98.5  |
| 13   | 12.0 | 05.1 | 73   | 67.2  | 28.5 | 133  | 122.4 | 52.0 | 193  | 177.7 | 75.4 | 253  | 232.9 | 98.8  |
| 14   | 12.9 | 05.5 | 74   | 68.1  | 28.9 | 134  | 123.3 | 52.4 | 194  | 178.6 | 75.8 | 254  | 233.8 | 99.2  |
| 15   | 13.8 | 05.9 | 75   | 69.0  | 29.3 | 135  | 124.3 | 52.7 | 195  | 179.5 | 76.2 | 255  | 234.7 | 99.6  |
| 16   | 14.7 | 06.3 | 76   | 70.0  | 29.7 | 136  | 125.2 | 53.1 | 196  | 180.4 | 76.6 | 256  | 235.6 | 100.0 |
| 17   | 15.6 | 06.6 | 77   | 70.9  | 30.1 | 137  | 126.1 | 53.5 | 197  | 181.3 | 77.0 | 257  | 236.6 | 100.4 |
| 18   | 16.6 | 07.0 | 78   | 71.8  | 30.5 | 138  | 127.0 | 53.9 | 198  | 182.3 | 77.4 | 258  | 237.5 | 100.8 |
| 19   | 17.5 | 07.4 | 79   | 72.7  | 30.9 | 139  | 127.9 | 54.3 | 199  | 183.2 | 77.7 | 259  | 238.4 | 101.2 |
| 20   | 18.4 | 07.8 | 80   | 73.6  | 31.3 | 140  | 128.9 | 54.7 | 200  | 184.1 | 78.1 | 260  | 239.3 | 101.6 |
| 21   | 19.3 | 08.2 | 81   | 74.6  | 31.6 | 141  | 129.8 | 55.1 | 201  | 185.0 | 78.5 | 261  | 240.2 | 102.0 |
| 22   | 20.3 | 08.6 | 82   | 75.5  | 32.0 | 142  | 130.7 | 55.5 | 202  | 185.9 | 78.9 | 262  | 241.2 | 102.4 |
| 23   | 21.2 | 09.0 | 83   | 76.4  | 32.4 | 143  | 131.6 | 55.9 | 203  | 186.9 | 79.3 | 263  | 242.1 | 102.8 |
| 24   | 22.1 | 09.4 | 84   | 77.3  | 32.8 | 144  | 132.6 | 56.3 | 204  | 187.8 | 79.7 | 264  | 243.0 | 103.1 |
| 25   | 23.0 | 09.8 | 85   | 78.2  | 33.2 | 145  | 133.5 | 56.7 | 205  | 188.7 | 80.1 | 265  | 243.9 | 103.5 |
| 26   | 23.9 | 10.2 | 86   | 79.2  | 33.6 | 146  | 134.4 | 57.0 | 206  | 189.6 | 80.5 | 266  | 244.9 | 103.9 |
| 27   | 24.9 | 10.5 | 87   | 80.1  | 34.0 | 147  | 135.3 | 57.4 | 207  | 190.5 | 80.9 | 267  | 245.8 | 104.3 |
| 28   | 25.8 | 10.9 | 88   | 81.0  | 34.4 | 148  | 136.2 | 57.8 | 208  | 191.5 | 81.3 | 268  | 246.7 | 104.7 |
| 29   | 26.7 | 11.3 | 89   | 81.9  | 34.8 | 149  | 137.2 | 58.2 | 209  | 192.4 | 81.7 | 269  | 247.6 | 105.1 |
| 30   | 27.6 | 11.7 | 90   | 82.8  | 35.2 | 150  | 138.1 | 58.6 | 210  | 193.3 | 82.0 | 270  | 248.5 | 105.5 |
| 31   | 28.5 | 12.1 | 91   | 83.8  | 35.6 | 151  | 139.0 | 59.0 | 211  | 194.2 | 82.4 | 271  | 249.5 | 105.9 |
| 32   | 29.5 | 12.5 | 92   | 84.7  | 35.9 | 152  | 139.9 | 59.4 | 212  | 195.1 | 82.8 | 272  | 250.4 | 106.3 |
| 33   | 30.4 | 12.9 | 93   | 85.6  | 36.3 | 153  | 140.8 | 59.8 | 213  | 196.1 | 83.2 | 273  | 251.3 | 106.7 |
| 34   | 31.3 | 13.3 | 94   | 86.5  | 36.7 | 154  | 141.8 | 60.2 | 214  | 197.0 | 83.6 | 274  | 252.2 | 107.1 |
| 35   | 32.2 | 13.7 | 95   | 87.4  | 37.1 | 155  | 142.7 | 60.6 | 215  | 197.9 | 84.0 | 275  | 253.1 | 107.4 |
| 36   | 33.1 | 14.1 | 96   | 88.4  | 37.5 | 156  | 143.6 | 60.9 | 216  | 198.8 | 84.4 | 276  | 254.1 | 107.8 |
| 37   | 34.1 | 14.5 | 97   | 89.3  | 37.9 | 157  | 144.5 | 61.3 | 217  | 199.7 | 84.8 | 277  | 255.0 | 108.2 |
| 38   | 35.0 | 14.8 | 98   | 90.2  | 38.3 | 158  | 145.4 | 61.7 | 218  | 200.7 | 85.2 | 278  | 255.9 | 108.6 |
| 39   | 35.9 | 15.2 | 99   | 91.1  | 38.7 | 159  | 146.4 | 62.1 | 219  | 201.6 | 85.6 | 279  | 256.8 | 109.0 |
| 40   | 36.8 | 15.6 | 100  | 92.0  | 39.1 | 160  | 147.3 | 62.5 | 220  | 202.5 | 86.0 | 280  | 257.7 | 109.4 |
| 41   | 37.7 | 16.0 | 101  | 93.0  | 39.5 | 161  | 148.2 | 62.9 | 221  | 203.4 | 86.3 | 281  | 258.7 | 109.8 |
| 42   | 38.7 | 16.4 | 102  | 93.9  | 39.9 | 162  | 149.1 | 63.3 | 222  | 204.4 | 86.7 | 282  | 259.6 | 110.2 |
| 43   | 39.6 | 16.8 | 103  | 94.8  | 40.2 | 163  | 150.0 | 63.7 | 223  | 205.3 | 87.1 | 283  | 260.5 | 110.6 |
| 44   | 40.5 | 17.2 | 104  | 95.7  | 40.6 | 164  | 151.0 | 64.1 | 224  | 206.2 | 87.5 | 284  | 261.4 | 111.0 |
| 45   | 41.4 | 17.6 | 105  | 96.7  | 41.0 | 165  | 151.9 | 64.5 | 225  | 207.1 | 87.9 | 285  | 262.3 | 111.3 |
| 46   | 42.3 | 18.0 | 106  | 97.6  | 41.4 | 166  | 152.8 | 64.9 | 226  | 208.0 | 88.3 | 286  | 263.3 | 111.7 |
| 47   | 43.3 | 18.4 | 107  | 98.5  | 41.8 | 167  | 153.7 | 65.2 | 227  | 209.0 | 88.7 | 287  | 264.2 | 112.1 |
| 48   | 44.2 | 18.8 | 108  | 99.4  | 42.2 | 168  | 154.6 | 65.6 | 228  | 209.9 | 89.1 | 288  | 265.1 | 112.5 |
| 49   | 45.1 | 19.1 | 109  | 100.3 | 42.6 | 169  | 155.6 | 66.0 | 229  | 210.8 | 89.5 | 289  | 266.0 | 112.9 |
| 50   | 46.0 | 19.5 | 110  | 101.3 | 43.0 | 170  | 156.5 | 66.4 | 230  | 211.7 | 89.9 | 290  | 266.9 | 113.3 |
| 51   | 46.9 | 19.9 | 111  | 102.2 | 43.4 | 171  | 157.4 | 66.8 | 231  | 212.6 | 90.3 | 291  | 267.9 | 113.7 |
| 52   | 47.9 | 20.3 | 112  | 103.1 | 43.8 | 172  | 158.3 | 67.2 | 232  | 213.6 | 90.6 | 292  | 268.8 | 114.1 |
| 53   | 48.8 | 20.7 | 113  | 104.0 | 44.1 | 173  | 159.2 | 67.6 | 233  | 214.5 | 91.0 | 293  | 269.7 | 114.5 |
| 54   | 49.7 | 21.1 | 114  | 104.9 | 44.5 | 174  | 160.2 | 68.0 | 234  | 215.4 | 91.4 | 294  | 270.6 | 114.9 |
| 55   | 50.6 | 21.5 | 115  | 105.9 | 44.9 | 175  | 161.1 | 68.4 | 235  | 216.3 | 91.8 | 295  | 271.5 | 115.3 |
| 56   | 51.5 | 21.9 | 116  | 106.8 | 45.3 | 176  | 162.0 | 68.8 | 236  | 217.2 | 92.2 | 296  | 272.5 | 115.6 |
| 57   | 52.5 | 22.3 | 117  | 107.7 | 45.7 | 177  | 162.9 | 69.2 | 237  | 218.2 | 92.6 | 297  | 273.4 | 116.0 |
| 58   | 53.4 | 22.7 | 118  | 108.6 | 46.1 | 178  | 163.8 | 69.5 | 238  | 219.1 | 93.0 | 298  | 274.3 | 116.4 |
| 59   | 54.3 | 23.1 | 119  | 109.5 | 46.5 | 179  | 164.8 | 69.9 | 239  | 220.0 | 93.4 | 299  | 275.2 | 116.8 |
| 60   | 55.2 | 23.4 | 120  | 110.5 | 46.9 | 180  | 165.7 | 70.3 | 240  | 220.9 | 93.8 | 300  | 276.2 | 117.2 |
| Dist | Dep  | Lat. | Dist | Dep   | Lat. | Dist | Dep   | Lat. | Dist | Dep   | Lat. | Dist | Dep   | Lat.  |

for 67 Degrees.

TABLE III. Difference of Latitude and Departure for 24 Degrees.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep   |
|------|------|------|------|-------|------|------|-------|------|------|-------|------|------|-------|-------|
| 1    | 00.9 | 00.4 | 61   | 55.7  | 24.8 | 121  | 110.5 | 49.2 | 181  | 165.3 | 73.6 | 241  | 220.2 | 98.0  |
| 2    | 01.8 | 00.8 | 62   | 56.6  | 25.2 | 122  | 111.4 | 49.6 | 82   | 166.3 | 74.0 | 42   | 221.1 | 98.4  |
| 3    | 02.7 | 01.2 | 63   | 57.6  | 25.6 | 23   | 112.4 | 50.0 | 83   | 167.2 | 74.4 | 43   | 222.0 | 98.8  |
| 4    | 03.7 | 01.6 | 64   | 58.5  | 26.0 | 24   | 113.3 | 50.4 | 84   | 168.1 | 74.8 | 44   | 222.9 | 99.2  |
| 5    | 04.6 | 02.0 | 65   | 59.4  | 26.4 | 25   | 114.2 | 50.8 | 85   | 169.0 | 75.2 | 45   | 223.8 | 99.6  |
| 6    | 05.5 | 02.4 | 66   | 60.3  | 26.8 | 26   | 115.1 | 51.2 | 86   | 169.9 | 75.6 | 46   | 224.7 | 100.0 |
| 7    | 06.4 | 02.8 | 67   | 61.2  | 27.2 | 27   | 116.0 | 51.7 | 87   | 170.8 | 76.1 | 47   | 225.6 | 100.5 |
| 8    | 07.3 | 03.3 | 68   | 62.1  | 27.7 | 28   | 116.9 | 52.1 | 88   | 171.7 | 76.5 | 48   | 226.5 | 100.9 |
| 9    | 08.2 | 03.7 | 69   | 63.0  | 28.1 | 29   | 117.8 | 52.5 | 89   | 172.7 | 76.9 | 49   | 227.5 | 101.3 |
| 10   | 09.1 | 04.1 | 70   | 63.9  | 28.5 | 30   | 118.8 | 52.9 | 90   | 173.6 | 77.3 | 50   | 228.4 | 101.7 |
| 11   | 10.0 | 04.5 | 71   | 64.9  | 28.9 | 31   | 119.7 | 53.3 | 191  | 174.5 | 77.7 | 251  | 229.3 | 102.1 |
| 12   | 11.0 | 04.9 | 72   | 65.8  | 29.3 | 32   | 120.6 | 53.7 | 92   | 175.4 | 78.1 | 52   | 230.2 | 102.5 |
| 13   | 11.9 | 05.3 | 73   | 66.7  | 29.7 | 33   | 121.5 | 54.1 | 93   | 176.3 | 78.5 | 53   | 231.1 | 102.9 |
| 14   | 12.8 | 05.7 | 74   | 67.6  | 30.1 | 34   | 122.4 | 54.5 | 94   | 177.2 | 78.9 | 54   | 232.0 | 103.3 |
| 15   | 13.7 | 06.1 | 75   | 68.5  | 30.5 | 35   | 123.3 | 54.9 | 95   | 178.1 | 79.3 | 55   | 232.9 | 103.7 |
| 16   | 14.6 | 06.5 | 76   | 69.4  | 30.9 | 36   | 124.2 | 55.3 | 96   | 179.0 | 79.7 | 56   | 233.8 | 104.1 |
| 17   | 15.5 | 06.9 | 77   | 70.3  | 31.3 | 37   | 125.1 | 55.7 | 97   | 180.0 | 80.1 | 57   | 234.7 | 104.5 |
| 18   | 16.4 | 07.3 | 78   | 71.3  | 31.7 | 38   | 126.1 | 56.1 | 98   | 180.9 | 80.5 | 58   | 235.6 | 104.9 |
| 19   | 17.4 | 07.7 | 79   | 72.2  | 32.1 | 39   | 127.0 | 56.5 | 99   | 181.8 | 80.9 | 59   | 236.5 | 105.3 |
| 20   | 18.3 | 08.1 | 80   | 73.1  | 32.5 | 40   | 127.9 | 56.9 | 200  | 182.7 | 81.3 | 60   | 237.4 | 105.7 |
| 21   | 19.2 | 08.5 | 81   | 74.0  | 32.9 | 141  | 128.8 | 57.3 | 201  | 183.6 | 81.7 | 261  | 238.3 | 106.1 |
| 22   | 20.1 | 08.9 | 82   | 74.9  | 33.3 | 42   | 129.7 | 57.8 | 02   | 184.5 | 82.2 | 62   | 239.2 | 106.5 |
| 23   | 21.0 | 09.4 | 83   | 75.8  | 33.8 | 43   | 130.6 | 58.2 | 03   | 185.4 | 82.6 | 63   | 240.1 | 106.9 |
| 24   | 21.9 | 09.8 | 84   | 76.7  | 34.2 | 44   | 131.5 | 58.6 | 04   | 186.4 | 83.0 | 64   | 241.0 | 107.3 |
| 25   | 22.8 | 10.2 | 85   | 77.6  | 34.6 | 45   | 132.5 | 59.0 | 05   | 187.3 | 83.4 | 65   | 241.9 | 107.7 |
| 26   | 23.8 | 10.6 | 86   | 78.6  | 35.0 | 46   | 133.4 | 59.4 | 06   | 188.2 | 83.8 | 66   | 242.8 | 108.1 |
| 27   | 24.7 | 11.0 | 87   | 79.5  | 35.4 | 47   | 134.3 | 59.8 | 07   | 189.1 | 84.2 | 67   | 243.7 | 108.5 |
| 28   | 25.6 | 11.4 | 88   | 80.4  | 35.8 | 48   | 135.2 | 60.2 | 08   | 190.0 | 84.6 | 68   | 244.6 | 108.9 |
| 29   | 26.5 | 11.8 | 89   | 81.3  | 36.2 | 49   | 136.1 | 60.6 | 09   | 190.9 | 85.0 | 69   | 245.5 | 109.3 |
| 30   | 27.4 | 12.2 | 90   | 82.2  | 36.6 | 50   | 137.0 | 61.0 | 10   | 191.8 | 85.4 | 70   | 246.4 | 109.7 |
| 31   | 28.3 | 12.6 | 91   | 83.1  | 37.0 | 151  | 137.9 | 61.4 | 211  | 192.7 | 85.8 | 271  | 247.3 | 110.1 |
| 32   | 29.2 | 13.0 | 92   | 84.0  | 37.4 | 52   | 138.9 | 61.8 | 12   | 193.7 | 86.2 | 72   | 248.2 | 110.5 |
| 33   | 30.1 | 13.4 | 93   | 85.0  | 37.8 | 53   | 139.8 | 62.2 | 13   | 194.6 | 86.6 | 73   | 249.1 | 110.9 |
| 34   | 31.1 | 13.8 | 94   | 85.9  | 38.2 | 54   | 140.7 | 62.6 | 14   | 195.5 | 87.0 | 74   | 250.0 | 111.3 |
| 35   | 32.0 | 14.2 | 95   | 86.8  | 38.6 | 55   | 141.6 | 63.0 | 15   | 196.4 | 87.4 | 75   | 250.9 | 111.7 |
| 36   | 32.9 | 14.6 | 96   | 87.7  | 39.0 | 56   | 142.5 | 63.4 | 16   | 197.3 | 87.8 | 76   | 251.8 | 112.1 |
| 37   | 33.8 | 15.0 | 97   | 88.6  | 39.4 | 57   | 143.4 | 63.9 | 17   | 198.2 | 88.3 | 77   | 252.7 | 112.5 |
| 38   | 34.7 | 15.5 | 98   | 89.5  | 39.9 | 58   | 144.3 | 64.3 | 18   | 199.1 | 88.7 | 78   | 253.6 | 112.9 |
| 39   | 35.6 | 15.9 | 99   | 90.4  | 40.3 | 59   | 145.2 | 64.7 | 19   | 200.1 | 89.1 | 79   | 254.5 | 113.3 |
| 40   | 36.5 | 16.3 | 100  | 91.4  | 40.7 | 60   | 146.2 | 65.1 | 20   | 201.0 | 89.5 | 80   | 255.4 | 113.7 |
| 41   | 37.5 | 16.7 | 101  | 92.3  | 41.1 | 161  | 147.1 | 65.5 | 221  | 201.9 | 89.9 | 281  | 256.3 | 114.1 |
| 42   | 38.4 | 17.1 | 02   | 93.2  | 41.5 | 62   | 148.0 | 65.9 | 22   | 202.8 | 90.3 | 82   | 257.2 | 114.5 |
| 43   | 39.3 | 17.5 | 03   | 94.1  | 41.9 | 63   | 148.9 | 66.3 | 23   | 203.7 | 90.7 | 83   | 258.1 | 114.9 |
| 44   | 40.2 | 17.9 | 04   | 95.0  | 42.3 | 64   | 149.8 | 66.7 | 24   | 204.6 | 91.1 | 84   | 259.0 | 115.3 |
| 45   | 41.1 | 18.3 | 05   | 95.9  | 42.7 | 65   | 150.7 | 67.1 | 25   | 205.5 | 91.5 | 85   | 260.0 | 115.7 |
| 46   | 42.0 | 18.7 | 06   | 96.8  | 43.1 | 66   | 151.6 | 67.5 | 26   | 206.4 | 91.9 | 86   | 260.9 | 116.1 |
| 47   | 42.9 | 19.1 | 07   | 97.7  | 43.5 | 67   | 152.5 | 67.9 | 27   | 207.3 | 92.3 | 87   | 261.8 | 116.5 |
| 48   | 43.8 | 19.5 | 08   | 98.6  | 43.9 | 68   | 153.4 | 68.3 | 28   | 208.2 | 92.7 | 88   | 262.7 | 116.9 |
| 49   | 44.7 | 19.9 | 09   | 99.5  | 44.3 | 69   | 154.3 | 68.7 | 29   | 209.1 | 93.1 | 89   | 263.6 | 117.3 |
| 50   | 45.7 | 20.3 | 110  | 100.5 | 44.7 | 70   | 155.3 | 69.1 | 30   | 210.1 | 93.5 | 90   | 264.5 | 117.7 |
| 51   | 46.6 | 20.7 | 111  | 101.4 | 45.1 | 171  | 156.2 | 69.5 | 231  | 211.0 | 93.9 | 291  | 265.4 | 118.1 |
| 52   | 47.5 | 21.1 | 12   | 102.3 | 45.5 | 72   | 157.1 | 70.0 | 32   | 211.9 | 94.4 | 92   | 266.3 | 118.5 |
| 53   | 48.4 | 21.6 | 13   | 103.2 | 46.0 | 73   | 158.0 | 70.4 | 33   | 212.8 | 94.8 | 93   | 267.2 | 118.9 |
| 54   | 49.3 | 22.0 | 14   | 104.1 | 46.4 | 74   | 158.9 | 70.8 | 34   | 213.7 | 95.2 | 94   | 268.1 | 119.3 |
| 55   | 50.2 | 22.4 | 15   | 105.1 | 46.8 | 75   | 159.9 | 71.2 | 35   | 214.6 | 95.6 | 95   | 269.0 | 119.7 |
| 56   | 51.0 | 22.8 | 16   | 106.0 | 47.2 | 76   | 160.8 | 71.6 | 36   | 215.5 | 96.0 | 96   | 270.0 | 120.1 |
| 57   | 52.1 | 23.2 | 17   | 106.9 | 47.6 | 77   | 161.7 | 72.0 | 37   | 216.4 | 96.4 | 97   | 270.9 | 120.5 |
| 58   | 53.0 | 23.6 | 18   | 107.8 | 48.0 | 78   | 162.6 | 72.4 | 38   | 217.3 | 96.8 | 98   | 271.8 | 120.9 |
| 59   | 53.9 | 24.0 | 19   | 108.7 | 48.4 | 79   | 163.5 | 72.8 | 39   | 218.2 | 97.2 | 99   | 272.7 | 121.3 |
| 60   | 54.8 | 24.4 | 120  | 109.6 | 48.8 | 180  | 164.4 | 73.2 | 240  | 219.2 | 97.6 | 300  | 273.6 | 121.7 |

Dist Dep Lat Dist Dep Lat Dist Dep Lat Dist Dep Lat Dist Dep Lat

for 66 Degrees.



TABLE III. Difference of Latitude and Departure for 25 Degrees.

| Diff | Lat. | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep  | Diff | Lat.  | Dep.  | Diff | Lat.  | Dep.  |
|------|------|------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|
| 1    | 00.9 | 00.4 | 61   | 55.3  | 25.8 | 121  | 109.7 | 51.1 | 181  | 164.0 | 76.5  | 241  | 218.4 | 101.8 |
| 2    | 01.8 | 00.8 | 62   | 56.2  | 26.2 | 122  | 110.6 | 51.6 | 82   | 164.9 | 76.9  | 42   | 219.3 | 102.2 |
| 3    | 02.7 | 01.2 | 63   | 57.1  | 26.6 | 123  | 111.5 | 52.0 | 83   | 165.9 | 77.3  | 43   | 220.2 | 102.7 |
| 4    | 03.6 | 01.7 | 64   | 58.0  | 27.0 | 124  | 112.4 | 52.4 | 84   | 166.8 | 77.8  | 44   | 221.1 | 103.1 |
| 5    | 04.5 | 02.1 | 65   | 58.9  | 27.5 | 125  | 113.3 | 52.8 | 85   | 167.7 | 78.2  | 45   | 222.0 | 103.5 |
| 6    | 05.4 | 02.5 | 66   | 59.8  | 27.9 | 126  | 114.2 | 53.2 | 86   | 168.6 | 78.6  | 46   | 222.9 | 104.0 |
| 7    | 06.3 | 03.0 | 67   | 60.7  | 28.3 | 127  | 115.1 | 53.7 | 87   | 169.5 | 79.0  | 47   | 223.9 | 104.4 |
| 8    | 07.3 | 03.4 | 68   | 61.6  | 28.7 | 128  | 116.0 | 54.1 | 88   | 170.4 | 79.4  | 48   | 224.8 | 104.8 |
| 9    | 08.2 | 03.8 | 69   | 62.5  | 29.2 | 129  | 116.9 | 54.5 | 89   | 171.3 | 79.9  | 49   | 225.7 | 105.2 |
| 10   | 09.1 | 04.2 | 70   | 63.4  | 29.6 | 130  | 117.8 | 54.9 | 90   | 172.2 | 80.3  | 50   | 226.6 | 105.7 |
| 11   | 10.0 | 04.6 | 71   | 64.3  | 30.0 | 131  | 118.7 | 55.4 | 191  | 173.1 | 80.7  | 251  | 227.5 | 106.1 |
| 12   | 10.9 | 05.0 | 72   | 65.3  | 30.4 | 32   | 119.6 | 55.8 | 92   | 174.0 | 81.1  | 52   | 228.4 | 106.5 |
| 13   | 11.8 | 05.5 | 73   | 66.2  | 30.8 | 33   | 120.5 | 56.2 | 93   | 174.9 | 81.6  | 53   | 229.3 | 106.9 |
| 14   | 12.7 | 05.9 | 74   | 67.1  | 31.3 | 34   | 121.4 | 56.6 | 94   | 175.8 | 82.0  | 54   | 230.2 | 107.3 |
| 15   | 13.6 | 06.3 | 75   | 68.0  | 31.7 | 35   | 122.4 | 57.1 | 95   | 176.7 | 82.4  | 55   | 231.1 | 107.8 |
| 16   | 14.5 | 06.8 | 76   | 68.9  | 32.1 | 36   | 123.3 | 57.5 | 96   | 177.6 | 82.8  | 56   | 232.0 | 108.2 |
| 17   | 15.4 | 07.2 | 77   | 69.8  | 32.5 | 37   | 124.2 | 57.9 | 97   | 178.5 | 83.3  | 57   | 232.9 | 108.6 |
| 18   | 16.3 | 07.6 | 78   | 70.7  | 33.0 | 38   | 125.1 | 58.3 | 98   | 179.4 | 83.7  | 58   | 233.8 | 109.0 |
| 19   | 17.2 | 08.0 | 79   | 71.6  | 33.4 | 39   | 126.0 | 58.7 | 99   | 180.4 | 84.1  | 59   | 234.7 | 109.5 |
| 20   | 18.1 | 08.5 | 80   | 72.5  | 33.8 | 40   | 126.9 | 59.2 | 200  | 181.3 | 84.5  | 60   | 235.6 | 109.9 |
| 21   | 19.0 | 08.9 | 81   | 73.4  | 34.2 | 141  | 127.8 | 59.6 | 201  | 182.2 | 84.9  | 261  | 236.5 | 110.3 |
| 22   | 19.9 | 09.3 | 82   | 74.3  | 34.7 | 42   | 128.7 | 60.0 | 02   | 183.1 | 85.4  | 62   | 237.5 | 110.7 |
| 23   | 20.8 | 09.7 | 83   | 75.2  | 35.1 | 43   | 129.6 | 60.4 | 03   | 184.0 | 85.8  | 63   | 238.4 | 111.1 |
| 24   | 21.8 | 10.1 | 84   | 76.1  | 35.5 | 44   | 130.5 | 60.9 | 04   | 184.9 | 86.2  | 64   | 239.3 | 111.6 |
| 25   | 22.7 | 10.6 | 85   | 77.0  | 35.9 | 45   | 131.4 | 61.3 | 05   | 185.8 | 86.6  | 65   | 240.2 | 112.0 |
| 26   | 23.6 | 11.0 | 86   | 77.9  | 36.3 | 46   | 132.3 | 61.7 | 06   | 186.7 | 87.1  | 66   | 241.1 | 112.4 |
| 27   | 24.5 | 11.4 | 87   | 78.8  | 36.8 | 47   | 133.2 | 62.1 | 07   | 187.6 | 87.5  | 67   | 242.0 | 112.8 |
| 28   | 25.4 | 11.8 | 88   | 79.8  | 37.2 | 48   | 134.1 | 62.5 | 08   | 188.5 | 87.9  | 68   | 242.9 | 113.3 |
| 29   | 26.3 | 12.3 | 89   | 80.7  | 37.6 | 49   | 135.0 | 63.0 | 09   | 189.4 | 88.3  | 69   | 243.8 | 113.7 |
| 30   | 27.2 | 12.7 | 90   | 81.6  | 38.0 | 50   | 135.9 | 63.4 | 10   | 190.3 | 88.7  | 70   | 244.7 | 114.1 |
| 31   | 28.1 | 13.1 | 91   | 82.5  | 38.5 | 151  | 136.9 | 63.8 | 211  | 191.2 | 89.2  | 271  | 245.6 | 114.5 |
| 32   | 29.0 | 13.5 | 92   | 83.4  | 38.9 | 52   | 137.8 | 64.2 | 12   | 192.1 | 89.6  | 72   | 246.5 | 114.9 |
| 33   | 29.9 | 13.9 | 93   | 84.3  | 39.3 | 53   | 138.7 | 64.7 | 13   | 193.0 | 90.0  | 73   | 247.4 | 115.4 |
| 34   | 30.8 | 14.4 | 94   | 85.2  | 39.7 | 54   | 139.6 | 65.1 | 14   | 193.9 | 90.4  | 74   | 248.3 | 115.8 |
| 35   | 31.7 | 14.8 | 95   | 86.1  | 40.1 | 55   | 140.5 | 65.5 | 15   | 194.9 | 90.9  | 75   | 249.2 | 116.2 |
| 36   | 32.6 | 15.2 | 96   | 87.0  | 40.6 | 56   | 141.4 | 65.9 | 16   | 195.8 | 91.3  | 76   | 250.1 | 116.6 |
| 37   | 33.5 | 15.6 | 97   | 87.9  | 41.0 | 57   | 142.3 | 66.3 | 17   | 196.7 | 91.7  | 77   | 251.0 | 117.1 |
| 38   | 34.4 | 16.1 | 98   | 88.8  | 41.4 | 58   | 143.2 | 66.8 | 18   | 197.6 | 92.1  | 78   | 252.0 | 117.5 |
| 39   | 35.3 | 16.5 | 99   | 89.7  | 41.8 | 59   | 144.1 | 67.2 | 19   | 198.5 | 92.5  | 79   | 252.9 | 117.9 |
| 40   | 36.3 | 16.9 | 100  | 90.6  | 42.3 | 60   | 145.0 | 67.6 | 20   | 199.4 | 93.0  | 80   | 253.8 | 118.3 |
| 41   | 37.2 | 17.3 | 101  | 91.5  | 42.7 | 161  | 145.9 | 68.0 | 221  | 200.3 | 93.4  | 281  | 254.7 | 118.8 |
| 42   | 38.1 | 17.7 | 02   | 92.4  | 43.1 | 62   | 146.8 | 68.5 | 22   | 201.2 | 93.8  | 82   | 255.6 | 119.2 |
| 43   | 39.0 | 18.2 | 03   | 93.3  | 43.5 | 63   | 147.7 | 68.9 | 23   | 202.1 | 94.2  | 83   | 256.5 | 119.6 |
| 44   | 39.9 | 18.6 | 04   | 94.3  | 44.0 | 64   | 148.6 | 69.3 | 24   | 203.0 | 94.7  | 84   | 257.4 | 120.0 |
| 45   | 40.8 | 19.0 | 05   | 95.2  | 44.4 | 65   | 149.5 | 69.7 | 25   | 203.9 | 95.1  | 85   | 258.3 | 120.4 |
| 46   | 41.7 | 19.4 | 06   | 96.1  | 44.8 | 66   | 150.4 | 70.2 | 26   | 204.8 | 95.5  | 86   | 259.2 | 120.9 |
| 47   | 42.6 | 19.9 | 07   | 97.0  | 45.2 | 67   | 151.4 | 70.6 | 27   | 205.7 | 95.9  | 87   | 260.1 | 121.3 |
| 48   | 43.5 | 20.3 | 08   | 97.9  | 45.6 | 68   | 152.3 | 71.0 | 28   | 206.6 | 96.4  | 88   | 261.0 | 121.7 |
| 49   | 44.4 | 20.7 | 09   | 98.8  | 46.1 | 69   | 153.2 | 71.4 | 29   | 207.5 | 96.8  | 89   | 261.9 | 122.1 |
| 50   | 45.3 | 21.1 | 10   | 99.7  | 46.5 | 70   | 154.1 | 71.8 | 30   | 208.4 | 97.2  | 90   | 262.8 | 122.6 |
| 51   | 46.2 | 21.6 | 111  | 100.6 | 46.9 | 171  | 155.0 | 72.3 | 231  | 209.4 | 97.6  | 291  | 263.7 | 123.0 |
| 52   | 47.1 | 22.0 | 12   | 101.5 | 47.3 | 72   | 155.9 | 72.7 | 32   | 210.3 | 98.0  | 92   | 264.6 | 123.4 |
| 53   | 48.0 | 22.4 | 13   | 102.4 | 47.8 | 73   | 156.8 | 73.1 | 33   | 211.2 | 98.5  | 93   | 265.5 | 123.8 |
| 54   | 48.9 | 22.8 | 14   | 103.3 | 48.2 | 74   | 157.7 | 73.5 | 34   | 212.1 | 98.9  | 94   | 266.5 | 124.2 |
| 55   | 49.8 | 23.2 | 15   | 104.2 | 48.6 | 75   | 158.6 | 74.0 | 35   | 213.0 | 99.3  | 95   | 267.4 | 124.7 |
| 56   | 50.8 | 23.7 | 16   | 105.1 | 49.0 | 76   | 159.5 | 74.4 | 36   | 213.9 | 99.7  | 96   | 268.3 | 125.1 |
| 57   | 51.7 | 24.1 | 17   | 106.0 | 49.4 | 77   | 160.4 | 74.8 | 37   | 214.8 | 100.2 | 97   | 269.2 | 125.5 |
| 58   | 52.6 | 24.5 | 18   | 106.9 | 49.9 | 78   | 161.3 | 75.2 | 38   | 215.7 | 100.6 | 98   | 270.1 | 125.9 |
| 59   | 53.5 | 24.9 | 19   | 107.8 | 50.3 | 79   | 162.2 | 75.6 | 39   | 216.6 | 101.0 | 99   | 271.0 | 126.4 |
| 60   | 54.4 | 25.4 | 120  | 108.8 | 50.7 | 180  | 163.1 | 76.1 | 240  | 217.5 | 101.4 | 300  | 271.9 | 126.8 |
| Diff | Dep  | Lat. | Diff | Dep.  | Lat. | Diff | Dep.  | Lat. | Diff | Dep.  | Lat.  | Diff | Dep.  | Lat.  |

for 65 Degrees.

TABLE III. Difference of Latitude and Departure for 26 Degrees.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep   | Dist | Lat.  | Dep   | Dist | Lat.  | Dep   |
|------|------|------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.9 | 00.4 | 61   | 54.8  | 26.7 | 121  | 108.8 | 53.0 | 181  | 162.7 | 79.4  | 241  | 216.6 | 105.5 | 301  | 270.5 | 129.4 |
| 2    | 01.8 | 00.9 | 62   | 55.7  | 27.2 | 22   | 109.7 | 53.5 | 82   | 163.6 | 79.8  | 42   | 217.5 | 106.0 | 102  | 271.4 | 130.0 |
| 3    | 02.7 | 01.3 | 63   | 56.6  | 27.6 | 23   | 110.6 | 53.9 | 83   | 164.5 | 80.2  | 43   | 218.4 | 106.5 | 103  | 272.3 | 130.6 |
| 4    | 03.6 | 01.8 | 64   | 57.5  | 28.1 | 24   | 111.5 | 54.4 | 84   | 165.4 | 80.7  | 44   | 219.3 | 107.0 | 104  | 273.2 | 131.2 |
| 5    | 04.5 | 02.2 | 65   | 58.4  | 28.5 | 25   | 112.4 | 54.8 | 85   | 166.3 | 81.1  | 45   | 220.2 | 107.5 | 105  | 274.1 | 131.8 |
| 6    | 05.4 | 02.6 | 66   | 59.3  | 28.9 | 26   | 113.2 | 55.2 | 86   | 167.2 | 81.5  | 46   | 221.1 | 108.0 | 106  | 275.0 | 132.4 |
| 7    | 06.3 | 03.1 | 67   | 60.2  | 29.4 | 27   | 114.1 | 55.7 | 87   | 168.1 | 82.0  | 47   | 222.0 | 108.5 | 107  | 275.9 | 133.0 |
| 8    | 07.2 | 03.5 | 68   | 61.1  | 29.8 | 28   | 115.0 | 56.1 | 88   | 169.0 | 82.4  | 48   | 222.9 | 109.0 | 108  | 276.8 | 133.6 |
| 9    | 08.1 | 03.9 | 69   | 62.0  | 30.2 | 29   | 115.9 | 56.6 | 89   | 169.9 | 82.9  | 49   | 223.8 | 109.5 | 109  | 277.7 | 134.2 |
| 10   | 09.0 | 04.4 | 70   | 62.9  | 30.7 | 30   | 116.8 | 57.0 | 90   | 170.8 | 83.3  | 50   | 224.7 | 110.0 | 110  | 278.6 | 134.8 |
| 11   | 09.9 | 04.8 | 71   | 63.8  | 31.1 | 131  | 117.7 | 57.4 | 191  | 171.7 | 83.7  | 251  | 225.6 | 110.5 | 311  | 279.5 | 135.4 |
| 12   | 10.8 | 05.3 | 72   | 64.7  | 31.6 | 32   | 118.6 | 57.9 | 92   | 172.6 | 84.2  | 52   | 226.5 | 111.0 | 112  | 280.4 | 136.0 |
| 13   | 11.7 | 05.7 | 73   | 65.6  | 32.0 | 33   | 119.5 | 58.3 | 93   | 173.5 | 84.6  | 53   | 227.4 | 111.5 | 113  | 281.3 | 136.6 |
| 14   | 12.6 | 06.1 | 74   | 66.5  | 32.4 | 34   | 120.4 | 58.7 | 94   | 174.4 | 85.0  | 54   | 228.3 | 112.0 | 114  | 282.2 | 137.2 |
| 15   | 13.5 | 06.6 | 75   | 67.4  | 32.9 | 35   | 121.3 | 59.2 | 95   | 175.3 | 85.5  | 55   | 229.2 | 112.5 | 115  | 283.1 | 137.8 |
| 16   | 14.4 | 07.0 | 76   | 68.3  | 33.3 | 36   | 122.2 | 59.6 | 96   | 176.2 | 85.9  | 56   | 230.1 | 113.0 | 116  | 284.0 | 138.4 |
| 17   | 15.3 | 07.5 | 77   | 69.2  | 33.8 | 37   | 123.1 | 60.1 | 97   | 177.1 | 86.4  | 57   | 231.0 | 113.5 | 117  | 284.9 | 139.0 |
| 18   | 16.2 | 07.9 | 78   | 70.1  | 34.2 | 38   | 124.0 | 60.5 | 98   | 178.0 | 86.8  | 58   | 231.9 | 114.0 | 118  | 285.8 | 139.6 |
| 19   | 17.1 | 08.3 | 79   | 71.0  | 34.6 | 39   | 124.9 | 60.9 | 99   | 178.9 | 87.2  | 59   | 232.8 | 114.5 | 119  | 286.7 | 140.2 |
| 20   | 18.0 | 08.7 | 80   | 71.9  | 35.1 | 40   | 125.8 | 61.4 | 200  | 179.8 | 87.7  | 60   | 233.7 | 115.0 | 120  | 287.6 | 140.8 |
| 21   | 18.9 | 09.2 | 81   | 72.8  | 35.5 | 141  | 126.7 | 61.8 | 201  | 180.7 | 88.1  | 261  | 234.6 | 115.5 | 321  | 288.5 | 141.4 |
| 22   | 19.8 | 09.6 | 82   | 73.7  | 35.9 | 42   | 127.6 | 62.3 | 02   | 181.6 | 88.6  | 62   | 235.5 | 116.0 | 22   | 289.4 | 142.0 |
| 23   | 20.7 | 10.1 | 83   | 74.6  | 36.4 | 43   | 128.5 | 62.7 | 03   | 182.5 | 89.0  | 63   | 236.4 | 116.5 | 23   | 290.3 | 142.6 |
| 24   | 21.6 | 10.5 | 84   | 75.5  | 36.8 | 44   | 129.4 | 63.1 | 04   | 183.4 | 89.4  | 64   | 237.3 | 117.0 | 24   | 291.2 | 143.2 |
| 25   | 22.5 | 11.0 | 85   | 76.4  | 37.3 | 45   | 130.3 | 63.6 | 05   | 184.3 | 89.9  | 65   | 238.2 | 117.5 | 25   | 292.1 | 143.8 |
| 26   | 23.4 | 11.4 | 86   | 77.3  | 37.7 | 46   | 131.2 | 64.0 | 06   | 185.2 | 90.3  | 66   | 239.1 | 118.0 | 26   | 293.0 | 144.4 |
| 27   | 24.3 | 11.8 | 87   | 78.2  | 38.1 | 47   | 132.1 | 64.4 | 07   | 186.1 | 90.7  | 67   | 240.0 | 118.5 | 27   | 293.9 | 145.0 |
| 28   | 25.2 | 12.3 | 88   | 79.1  | 38.6 | 48   | 133.0 | 64.9 | 08   | 187.0 | 91.2  | 68   | 240.9 | 119.0 | 28   | 294.8 | 145.6 |
| 29   | 26.1 | 12.7 | 89   | 80.0  | 39.0 | 49   | 133.9 | 65.3 | 09   | 187.9 | 91.6  | 69   | 241.8 | 119.5 | 29   | 295.7 | 146.2 |
| 30   | 27.0 | 13.2 | 90   | 80.9  | 39.5 | 50   | 134.8 | 65.8 | 10   | 188.7 | 92.1  | 70   | 242.7 | 120.0 | 30   | 296.6 | 146.8 |
| 31   | 27.9 | 13.6 | 91   | 81.8  | 39.9 | 151  | 135.7 | 66.2 | 211  | 189.6 | 92.5  | 271  | 243.6 | 120.5 | 31   | 297.5 | 147.4 |
| 32   | 28.8 | 14.0 | 92   | 82.7  | 40.3 | 52   | 136.6 | 66.6 | 12   | 190.5 | 92.9  | 72   | 244.5 | 121.0 | 32   | 298.4 | 148.0 |
| 33   | 29.7 | 14.5 | 93   | 83.6  | 40.8 | 53   | 137.5 | 67.1 | 13   | 191.4 | 93.4  | 73   | 245.4 | 121.5 | 33   | 299.3 | 148.6 |
| 34   | 30.6 | 14.9 | 94   | 84.5  | 41.2 | 54   | 138.4 | 67.5 | 14   | 192.3 | 93.8  | 74   | 246.3 | 122.0 | 34   | 300.2 | 149.2 |
| 35   | 31.5 | 15.3 | 95   | 85.4  | 41.6 | 55   | 139.3 | 68.0 | 15   | 193.2 | 94.3  | 75   | 247.2 | 122.5 | 35   | 301.1 | 149.8 |
| 36   | 32.4 | 15.8 | 96   | 86.3  | 42.1 | 56   | 140.2 | 68.4 | 16   | 194.1 | 94.7  | 76   | 248.1 | 123.0 | 36   | 302.0 | 150.4 |
| 37   | 33.3 | 16.2 | 97   | 87.2  | 42.5 | 57   | 141.1 | 68.8 | 17   | 195.0 | 95.1  | 77   | 249.0 | 123.5 | 37   | 302.9 | 151.0 |
| 38   | 34.2 | 16.7 | 98   | 88.1  | 43.0 | 58   | 142.0 | 69.3 | 18   | 195.9 | 95.6  | 78   | 249.9 | 124.0 | 38   | 303.8 | 151.6 |
| 39   | 35.1 | 17.1 | 99   | 89.0  | 43.4 | 59   | 142.9 | 69.7 | 19   | 196.8 | 96.0  | 79   | 250.8 | 124.5 | 39   | 304.7 | 152.2 |
| 40   | 36.0 | 17.5 | 100  | 89.9  | 43.8 | 60   | 143.8 | 70.1 | 20   | 197.7 | 96.4  | 80   | 251.7 | 125.0 | 40   | 305.6 | 152.8 |
| 41   | 36.9 | 18.0 | 101  | 90.8  | 44.3 | 161  | 144.7 | 70.6 | 221  | 198.6 | 96.9  | 281  | 252.6 | 125.5 | 41   | 306.5 | 153.4 |
| 42   | 37.7 | 18.4 | 02   | 91.7  | 44.7 | 62   | 145.6 | 71.0 | 22   | 199.5 | 97.3  | 82   | 253.5 | 126.0 | 42   | 307.4 | 154.0 |
| 43   | 38.6 | 18.9 | 03   | 92.6  | 45.2 | 63   | 146.5 | 71.5 | 23   | 200.4 | 97.8  | 83   | 254.4 | 126.5 | 43   | 308.3 | 154.6 |
| 44   | 39.5 | 19.3 | 04   | 93.5  | 45.6 | 64   | 147.4 | 71.9 | 24   | 201.3 | 98.2  | 84   | 255.3 | 127.0 | 44   | 309.2 | 155.2 |
| 45   | 40.4 | 19.7 | 05   | 94.4  | 46.0 | 65   | 148.3 | 72.3 | 25   | 202.2 | 98.6  | 85   | 256.2 | 127.5 | 45   | 310.1 | 155.8 |
| 46   | 41.3 | 20.2 | 06   | 95.3  | 46.5 | 66   | 149.2 | 72.8 | 26   | 203.1 | 99.1  | 86   | 257.1 | 128.0 | 46   | 311.0 | 156.4 |
| 47   | 42.2 | 20.6 | 07   | 96.2  | 46.9 | 67   | 150.1 | 73.2 | 27   | 204.0 | 99.5  | 87   | 258.0 | 128.5 | 47   | 311.9 | 157.0 |
| 48   | 43.1 | 21.0 | 08   | 97.1  | 47.3 | 68   | 151.0 | 73.7 | 28   | 204.9 | 100.0 | 88   | 258.9 | 129.0 | 48   | 312.8 | 157.6 |
| 49   | 44.0 | 21.5 | 09   | 98.0  | 47.8 | 69   | 151.9 | 74.1 | 29   | 205.8 | 100.4 | 89   | 259.8 | 129.5 | 49   | 313.7 | 158.2 |
| 50   | 44.9 | 21.9 | 10   | 98.9  | 48.2 | 70   | 152.8 | 74.5 | 30   | 206.7 | 100.8 | 90   | 260.7 | 130.0 | 50   | 314.6 | 158.8 |
| 51   | 45.8 | 22.4 | 111  | 99.8  | 48.7 | 171  | 153.7 | 75.0 | 231  | 207.6 | 101.3 | 291  | 261.6 | 130.5 | 51   | 315.5 | 159.4 |
| 52   | 46.7 | 22.8 | 12   | 100.7 | 49.1 | 72   | 154.6 | 75.4 | 32   | 208.5 | 101.7 | 92   | 262.5 | 131.0 | 52   | 316.4 | 160.0 |
| 53   | 47.6 | 23.2 | 13   | 101.6 | 49.5 | 73   | 155.5 | 75.8 | 33   | 209.4 | 102.1 | 93   | 263.4 | 131.5 | 53   | 317.3 | 160.6 |
| 54   | 48.5 | 23.7 | 14   | 102.5 | 50.0 | 74   | 156.4 | 76.3 | 34   | 210.3 | 102.6 | 94   | 264.3 | 132.0 | 54   | 318.2 | 161.2 |
| 55   | 49.4 | 24.1 | 15   | 103.4 | 50.4 | 75   | 157.3 | 76.7 | 35   | 211.2 | 103.0 | 95   | 265.2 | 132.5 | 55   | 319.1 | 161.8 |
| 56   | 50.3 | 24.6 | 16   | 104.3 | 50.9 | 76   | 158.2 | 77.2 | 36   | 212.1 | 103.5 | 96   | 266.1 | 133.0 | 56   | 320.0 | 162.4 |
| 57   | 51.2 | 25.0 | 17   | 105.2 | 51.3 | 77   | 159.1 | 77.6 | 37   | 213.0 | 103.9 | 97   | 267.0 | 133.5 | 57   | 320.9 | 163.0 |
| 58   | 52.1 | 25.4 | 18   | 106.1 | 51.7 | 78   | 160.0 | 78.0 | 38   | 213.9 | 104.3 | 98   | 267.9 | 134.0 | 58   | 321.8 | 163.6 |
| 59   | 53.0 | 25.9 | 19   | 107.0 | 52.2 | 79   | 160.9 | 78.5 | 39   | 214.8 | 104.8 | 99   | 268.8 | 134.5 | 59   | 322.7 | 164.2 |
| 60   | 53.9 | 26.3 | 120  | 107.9 | 52.6 | 180  | 161.8 | 78.9 | 240  | 215.7 | 105.2 | 300  | 269.7 | 135.0 | 60   | 323.6 | 164.8 |
| Dist | Dep  | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  |

for 64 Degrees.

TABLE III. Difference of Latitude and Departure for 27 Degrees.

| Lat. | Dep. | Lat. | Dep. | Lat.  | Dep. | Lat. | Dep.  | Lat. | Dep. | Lat.  | Dep.  | Lat. | Dep.  | Lat.  | Dep. |
|------|------|------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|------|
| 105. | 00.9 | 00.5 | 61   | 54.4  | 27.7 | 121  | 107.8 | 54.9 | 181  | 161.3 | 82.2  | 241  | 214.7 | 109.4 |      |
| 106. | 01.8 | 00.9 | 62   | 55.2  | 28.1 | 22   | 108.7 | 55.4 | 82   | 162.2 | 82.6  | 42   | 215.6 | 109.9 |      |
| 106. | 02.7 | 01.4 | 63   | 56.1  | 28.6 | 23   | 109.6 | 55.8 | 83   | 163.1 | 83.1  | 43   | 216.5 | 110.3 |      |
| 107. | 03.6 | 01.8 | 64   | 57.0  | 29.1 | 24   | 110.5 | 56.3 | 84   | 163.9 | 83.5  | 44   | 217.4 | 110.8 |      |
| 107. | 04.5 | 02.3 | 65   | 57.9  | 29.5 | 25   | 111.4 | 56.8 | 85   | 164.8 | 84.0  | 45   | 218.3 | 111.2 |      |
| 107. | 05.3 | 02.7 | 66   | 58.8  | 30.0 | 26   | 112.3 | 57.2 | 86   | 165.7 | 84.4  | 46   | 219.2 | 111.7 |      |
| 108. | 06.2 | 03.2 | 67   | 59.7  | 30.4 | 27   | 113.2 | 57.7 | 87   | 166.6 | 84.9  | 47   | 220.1 | 112.1 |      |
| 108. | 07.1 | 03.6 | 68   | 60.6  | 30.9 | 28   | 114.0 | 58.1 | 88   | 167.5 | 85.4  | 48   | 221.0 | 112.6 |      |
| 109. | 08.0 | 04.1 | 69   | 61.5  | 31.3 | 29   | 114.9 | 58.6 | 89   | 168.4 | 85.8  | 49   | 221.9 | 113.0 |      |
| 109. | 08.9 | 04.5 | 70   | 62.4  | 31.8 | 30   | 115.8 | 59.0 | 90   | 169.3 | 86.3  | 50   | 222.8 | 113.5 |      |
| 110. | 09.8 | 05.0 | 71   | 63.3  | 32.2 | 131  | 116.7 | 59.5 | 191  | 170.2 | 86.7  | 251  | 223.6 | 114.0 |      |
| 110. | 10.7 | 05.4 | 72   | 64.2  | 32.7 | 32   | 117.6 | 59.9 | 92   | 171.1 | 87.2  | 52   | 224.5 | 114.4 |      |
| 110. | 11.6 | 05.9 | 73   | 65.0  | 33.1 | 33   | 118.5 | 60.4 | 93   | 172.0 | 87.6  | 53   | 225.4 | 114.9 |      |
| 111. | 12.5 | 06.4 | 74   | 65.9  | 33.6 | 34   | 119.4 | 60.8 | 94   | 172.9 | 88.1  | 54   | 226.3 | 115.3 |      |
| 111. | 13.4 | 06.8 | 75   | 66.8  | 34.1 | 35   | 120.3 | 61.3 | 95   | 173.7 | 88.5  | 55   | 227.2 | 115.8 |      |
| 112. | 14.3 | 07.3 | 76   | 67.7  | 34.5 | 36   | 121.2 | 61.7 | 96   | 174.6 | 89.0  | 56   | 228.1 | 116.2 |      |
| 112. | 15.1 | 07.7 | 77   | 68.6  | 35.0 | 37   | 122.1 | 62.2 | 97   | 175.5 | 89.4  | 57   | 229.0 | 116.7 |      |
| 113. | 16.0 | 08.2 | 78   | 69.5  | 35.4 | 38   | 123.0 | 62.7 | 98   | 176.4 | 89.9  | 58   | 229.9 | 117.1 |      |
| 113. | 16.9 | 08.6 | 79   | 70.4  | 35.9 | 39   | 123.8 | 63.1 | 99   | 177.3 | 90.3  | 59   | 230.8 | 117.6 |      |
| 114. | 17.8 | 09.1 | 80   | 71.3  | 36.3 | 40   | 124.7 | 63.6 | 200  | 178.2 | 90.8  | 60   | 231.7 | 118.0 |      |
| 114. | 18.7 | 09.5 | 81   | 72.2  | 36.8 | 141  | 125.6 | 64.0 | 201  | 179.1 | 91.3  | 201  | 232.6 | 118.5 |      |
| 114. | 19.6 | 10.0 | 82   | 73.1  | 37.2 | 42   | 126.5 | 64.5 | 02   | 180.0 | 91.7  | 62   | 233.4 | 118.9 |      |
| 115. | 20.5 | 10.4 | 83   | 74.0  | 37.7 | 43   | 127.4 | 64.9 | 03   | 180.9 | 92.2  | 63   | 234.3 | 119.4 |      |
| 115. | 21.4 | 10.9 | 84   | 74.8  | 38.1 | 44   | 128.3 | 65.4 | 04   | 181.8 | 92.6  | 64   | 235.2 | 119.9 |      |
| 116. | 22.3 | 11.4 | 85   | 75.7  | 38.6 | 45   | 129.2 | 65.8 | 05   | 182.7 | 93.1  | 65   | 236.1 | 120.3 |      |
| 116. | 23.2 | 11.8 | 86   | 76.6  | 39.0 | 46   | 130.1 | 66.3 | 06   | 183.5 | 93.5  | 66   | 237.0 | 120.8 |      |
| 117. | 24.1 | 12.3 | 87   | 77.5  | 39.5 | 47   | 131.0 | 66.7 | 07   | 184.4 | 94.0  | 67   | 237.9 | 121.2 |      |
| 117. | 24.9 | 12.7 | 88   | 78.4  | 40.0 | 48   | 131.9 | 67.2 | 08   | 185.3 | 94.4  | 68   | 238.8 | 121.7 |      |
| 117. | 25.8 | 13.2 | 89   | 79.3  | 40.4 | 49   | 132.8 | 67.6 | 09   | 186.2 | 94.9  | 69   | 239.7 | 122.1 |      |
| 118. | 26.7 | 13.6 | 90   | 80.2  | 40.9 | 50   | 133.7 | 68.1 | 10   | 187.1 | 95.3  | 70   | 240.6 | 122.6 |      |
| 118. | 27.6 | 14.1 | 91   | 81.1  | 41.3 | 151  | 134.5 | 68.6 | 211  | 188.0 | 95.8  | 271  | 241.5 | 123.1 |      |
| 119. | 28.5 | 14.5 | 92   | 82.0  | 41.8 | 52   | 135.4 | 69.0 | 12   | 188.9 | 96.2  | 72   | 242.4 | 123.5 |      |
| 119. | 29.4 | 15.0 | 93   | 82.9  | 42.2 | 53   | 136.3 | 69.5 | 13   | 189.8 | 96.7  | 73   | 243.2 | 123.9 |      |
| 120. | 30.3 | 15.4 | 94   | 83.8  | 42.7 | 54   | 137.2 | 69.9 | 14   | 190.7 | 97.2  | 74   | 244.1 | 124.4 |      |
| 120. | 31.2 | 15.9 | 95   | 84.6  | 43.1 | 55   | 138.1 | 70.4 | 15   | 191.6 | 97.6  | 75   | 245.0 | 124.9 |      |
| 121. | 32.1 | 16.3 | 96   | 85.5  | 43.6 | 56   | 139.0 | 70.8 | 16   | 192.5 | 98.1  | 76   | 245.9 | 125.3 |      |
| 121. | 33.0 | 16.8 | 97   | 86.4  | 44.0 | 57   | 139.9 | 71.3 | 17   | 193.3 | 98.5  | 77   | 246.8 | 125.8 |      |
| 121. | 33.9 | 17.3 | 98   | 87.3  | 44.5 | 58   | 140.8 | 71.7 | 18   | 194.2 | 99.0  | 78   | 247.7 | 126.2 |      |
| 122. | 34.7 | 17.7 | 99   | 88.2  | 44.9 | 59   | 141.7 | 72.2 | 19   | 195.1 | 99.4  | 79   | 248.6 | 126.7 |      |
| 122. | 35.6 | 18.2 | 100  | 89.1  | 45.4 | 60   | 142.6 | 72.6 | 20   | 196.0 | 99.9  | 80   | 249.5 | 127.1 |      |
| 123. | 36.5 | 18.6 | 101  | 90.0  | 45.9 | 161  | 143.5 | 73.1 | 221  | 196.9 | 100.3 | 281  | 250.4 | 127.6 |      |
| 123. | 37.4 | 19.1 | 02   | 90.9  | 46.3 | 62   | 144.3 | 73.5 | 22   | 197.8 | 100.8 | 82   | 251.3 | 128.0 |      |
| 124. | 38.3 | 19.5 | 03   | 91.8  | 46.8 | 63   | 145.2 | 74.0 | 23   | 198.7 | 101.2 | 83   | 252.2 | 128.5 |      |
| 124. | 39.2 | 20.0 | 04   | 92.7  | 47.2 | 64   | 146.1 | 74.5 | 24   | 199.6 | 101.7 | 84   | 253.0 | 128.9 |      |
| 124. | 40.1 | 20.4 | 05   | 93.6  | 47.7 | 65   | 147.0 | 74.9 | 25   | 200.5 | 102.2 | 85   | 253.9 | 129.4 |      |
| 125. | 41.0 | 20.9 | 06   | 94.4  | 48.1 | 66   | 147.9 | 75.4 | 26   | 201.4 | 102.6 | 86   | 254.8 | 129.8 |      |
| 125. | 41.9 | 21.3 | 07   | 95.3  | 48.6 | 67   | 148.8 | 75.8 | 27   | 202.3 | 103.1 | 87   | 255.7 | 130.3 |      |
| 126. | 42.8 | 21.8 | 08   | 96.2  | 49.0 | 68   | 149.7 | 76.3 | 28   | 203.1 | 103.5 | 88   | 256.6 | 130.8 |      |
| 126. | 43.7 | 22.2 | 09   | 97.1  | 49.5 | 69   | 150.6 | 76.7 | 29   | 204.0 | 104.0 | 89   | 257.5 | 131.2 |      |
| 127. | 44.6 | 22.7 | 10   | 98.0  | 49.9 | 70   | 151.5 | 77.2 | 30   | 204.9 | 104.4 | 90   | 258.4 | 131.7 |      |
| 127. | 45.4 | 23.2 | 111  | 98.9  | 50.4 | 171  | 152.4 | 77.6 | 231  | 205.8 | 104.9 | 291  | 259.3 | 132.1 |      |
| 128. | 46.3 | 23.6 | 12   | 99.8  | 50.8 | 72   | 153.3 | 78.1 | 32   | 206.7 | 105.3 | 92   | 260.2 | 132.6 |      |
| 128. | 47.2 | 24.1 | 13   | 100.7 | 51.3 | 73   | 154.1 | 78.5 | 33   | 207.6 | 105.8 | 93   | 261.1 | 133.0 |      |
| 128. | 48.1 | 24.5 | 14   | 101.6 | 51.8 | 74   | 155.0 | 79.0 | 34   | 208.5 | 106.2 | 94   | 262.0 | 133.5 |      |
| 129. | 49.0 | 25.0 | 15   | 102.5 | 52.2 | 75   | 155.9 | 79.5 | 35   | 209.4 | 106.7 | 95   | 262.8 | 133.9 |      |
| 129. | 49.9 | 25.4 | 16   | 103.4 | 52.7 | 76   | 156.8 | 79.9 | 36   | 210.3 | 107.1 | 96   | 263.7 | 134.4 |      |
| 130. | 50.8 | 25.9 | 17   | 104.2 | 53.1 | 77   | 157.7 | 80.4 | 37   | 211.2 | 107.6 | 97   | 264.6 | 134.8 |      |
| 130. | 51.7 | 26.3 | 18   | 105.1 | 53.6 | 78   | 158.6 | 80.8 | 38   | 212.1 | 108.1 | 98   | 265.5 | 135.3 |      |
| 131. | 52.6 | 26.8 | 19   | 106.0 | 54.0 | 79   | 159.5 | 81.3 | 39   | 212.9 | 108.5 | 99   | 266.4 | 135.7 |      |
| 131. | 53.5 | 27.2 | 120  | 106.9 | 54.5 | 180  | 160.4 | 81.7 | 240  | 213.8 | 109.0 | 300  | 267.3 | 136.2 |      |

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for 63 Degrees.



TABLE III. Difference of Latitude and Departure for 28 Degrees.

| Dist | Lat  | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep   | Dist | Lat   | Dep   |
|------|------|------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|
| 1    | 00.9 | 00.5 | 61   | 53.9  | 28.6 | 121  | 106.8 | 56.8 | 181  | 159.8 | 85.0  | 241  | 212.8 | 113.0 |
| 2    | 01.8 | 00.9 | 62   | 54.7  | 29.1 | 22   | 107.7 | 57.3 | 82   | 160.7 | 85.4  | 42   | 213.7 | 113.3 |
| 3    | 02.6 | 01.4 | 63   | 55.6  | 29.6 | 23   | 108.6 | 57.7 | 83   | 161.6 | 85.9  | 43   | 214.6 | 114.4 |
| 4    | 03.5 | 01.9 | 64   | 56.5  | 30.0 | 24   | 109.5 | 58.2 | 84   | 162.5 | 86.4  | 44   | 215.5 | 115.4 |
| 5    | 04.4 | 02.3 | 65   | 57.4  | 30.5 | 25   | 110.4 | 58.7 | 85   | 163.4 | 86.9  | 45   | 216.3 | 115.5 |
| 6    | 05.3 | 02.8 | 66   | 58.3  | 31.0 | 26   | 111.3 | 59.2 | 86   | 164.2 | 87.3  | 46   | 217.2 | 115.5 |
| 7    | 06.2 | 03.3 | 67   | 59.2  | 31.5 | 27   | 112.1 | 59.6 | 87   | 165.1 | 87.8  | 47   | 218.1 | 115.5 |
| 8    | 07.1 | 03.8 | 68   | 60.0  | 31.9 | 28   | 113.0 | 60.1 | 88   | 166.0 | 88.3  | 48   | 219.0 | 116.6 |
| 9    | 07.9 | 04.3 | 69   | 60.9  | 32.4 | 29   | 113.9 | 60.6 | 89   | 166.9 | 88.7  | 49   | 219.9 | 116.6 |
| 10   | 08.8 | 04.7 | 70   | 61.8  | 32.9 | 30   | 114.8 | 61.0 | 90   | 167.8 | 89.2  | 50   | 220.8 | 117.7 |
| 11   | 09.7 | 05.2 | 71   | 62.7  | 33.3 | 131  | 115.7 | 61.5 | 191  | 168.7 | 89.7  | 251  | 221.6 | 117.7 |
| 12   | 10.6 | 05.6 | 72   | 63.6  | 33.8 | 32   | 116.6 | 62.0 | 92   | 169.5 | 90.1  | 52   | 222.5 | 118.8 |
| 13   | 11.5 | 06.1 | 73   | 64.5  | 34.3 | 33   | 117.4 | 62.4 | 93   | 170.4 | 90.6  | 53   | 223.4 | 118.8 |
| 14   | 12.4 | 06.6 | 74   | 65.3  | 34.7 | 34   | 118.3 | 62.9 | 94   | 171.3 | 91.1  | 54   | 224.3 | 119.9 |
| 15   | 13.2 | 07.0 | 75   | 66.2  | 35.2 | 35   | 119.2 | 63.4 | 95   | 172.2 | 91.6  | 55   | 225.2 | 119.9 |
| 16   | 14.1 | 07.5 | 76   | 67.1  | 35.7 | 36   | 120.1 | 63.9 | 96   | 173.1 | 92.0  | 56   | 226.0 | 120.0 |
| 17   | 15.0 | 08.0 | 77   | 68.0  | 36.2 | 37   | 121.0 | 64.3 | 97   | 174.0 | 92.5  | 57   | 226.9 | 120.0 |
| 18   | 16.9 | 08.5 | 78   | 68.9  | 36.6 | 38   | 121.9 | 64.8 | 98   | 174.8 | 93.0  | 58   | 227.8 | 121.1 |
| 19   | 16.8 | 08.9 | 79   | 69.8  | 37.1 | 39   | 122.7 | 65.3 | 99   | 175.7 | 93.4  | 59   | 228.7 | 121.1 |
| 20   | 17.7 | 09.4 | 80   | 70.6  | 37.6 | 40   | 123.6 | 65.7 | 200  | 176.6 | 93.9  | 60   | 229.6 | 122.2 |
| 21   | 18.5 | 09.9 | 81   | 71.5  | 38.0 | 141  | 124.5 | 66.2 | 201  | 177.5 | 94.4  | 261  | 230.5 | 122.2 |
| 22   | 19.4 | 10.3 | 82   | 72.4  | 38.5 | 42   | 125.4 | 66.7 | 02   | 178.4 | 94.8  | 62   | 231.3 | 123.3 |
| 23   | 20.3 | 10.8 | 83   | 73.3  | 39.0 | 43   | 126.3 | 67.1 | 03   | 179.2 | 95.3  | 63   | 232.2 | 123.3 |
| 24   | 21.2 | 11.3 | 84   | 74.2  | 39.4 | 44   | 127.2 | 67.6 | 04   | 180.1 | 95.8  | 64   | 233.1 | 123.3 |
| 25   | 22.1 | 11.7 | 85   | 75.1  | 39.9 | 45   | 128.0 | 68.1 | 05   | 181.0 | 96.2  | 65   | 234.0 | 124.4 |
| 26   | 23.0 | 12.2 | 86   | 75.9  | 40.4 | 46   | 128.9 | 68.5 | 06   | 181.9 | 96.7  | 66   | 234.9 | 124.4 |
| 27   | 23.8 | 12.7 | 87   | 76.8  | 40.8 | 47   | 129.8 | 69.0 | 07   | 182.8 | 97.2  | 67   | 235.8 | 125.5 |
| 28   | 24.7 | 13.1 | 88   | 77.7  | 41.3 | 48   | 130.7 | 69.5 | 08   | 183.7 | 97.7  | 68   | 236.6 | 125.5 |
| 29   | 25.6 | 13.6 | 89   | 78.6  | 41.8 | 49   | 131.6 | 70.0 | 09   | 184.5 | 98.1  | 69   | 237.5 | 126.6 |
| 30   | 26.5 | 14.1 | 90   | 79.5  | 42.3 | 50   | 132.5 | 70.4 | 10   | 185.4 | 98.6  | 70   | 238.4 | 126.6 |
| 31   | 27.4 | 14.6 | 91   | 80.4  | 42.7 | 151  | 133.3 | 70.9 | 211  | 186.3 | 99.1  | 271  | 239.3 | 127.7 |
| 32   | 28.3 | 15.0 | 92   | 81.2  | 43.2 | 52   | 134.2 | 71.4 | 12   | 187.2 | 99.5  | 72   | 240.2 | 127.7 |
| 33   | 29.1 | 15.5 | 93   | 82.1  | 43.7 | 53   | 135.1 | 71.8 | 13   | 188.1 | 100.0 | 73   | 241.1 | 128.8 |
| 34   | 30.0 | 16.0 | 94   | 83.0  | 44.1 | 54   | 136.0 | 72.3 | 14   | 189.0 | 100.5 | 74   | 241.9 | 128.8 |
| 35   | 30.9 | 16.4 | 95   | 83.9  | 44.6 | 55   | 136.9 | 72.8 | 15   | 189.8 | 100.9 | 75   | 242.8 | 129.9 |
| 36   | 31.8 | 16.9 | 96   | 84.8  | 45.1 | 56   | 137.7 | 73.2 | 16   | 190.7 | 101.4 | 76   | 243.7 | 129.9 |
| 37   | 32.7 | 17.4 | 97   | 85.7  | 45.5 | 57   | 138.6 | 73.7 | 17   | 191.6 | 101.9 | 77   | 244.6 | 130.0 |
| 38   | 33.6 | 17.8 | 98   | 86.5  | 46.0 | 58   | 139.5 | 74.2 | 18   | 192.5 | 102.4 | 78   | 245.5 | 131.1 |
| 39   | 34.5 | 18.3 | 99   | 87.4  | 46.5 | 59   | 140.4 | 74.6 | 19   | 193.4 | 102.8 | 79   | 246.4 | 131.1 |
| 40   | 35.3 | 18.8 | 100  | 88.3  | 47.0 | 60   | 141.3 | 75.1 | 20   | 194.3 | 103.3 | 80   | 247.2 | 132.2 |
| 41   | 36.2 | 19.2 | 101  | 89.2  | 47.4 | 161  | 142.2 | 75.6 | 221  | 195.1 | 103.8 | 281  | 248.1 | 132.2 |
| 42   | 37.1 | 19.7 | 02   | 90.1  | 47.9 | 62   | 143.0 | 76.1 | 22   | 196.0 | 104.2 | 82   | 249.0 | 133.3 |
| 43   | 38.0 | 20.2 | 03   | 90.9  | 48.4 | 63   | 143.9 | 76.5 | 23   | 196.9 | 104.7 | 83   | 249.9 | 133.3 |
| 44   | 38.9 | 20.7 | 04   | 91.8  | 48.8 | 64   | 144.8 | 77.0 | 24   | 197.8 | 105.2 | 84   | 250.8 | 134.4 |
| 45   | 39.7 | 21.1 | 05   | 92.7  | 49.3 | 65   | 145.7 | 77.5 | 25   | 198.7 | 105.6 | 85   | 251.7 | 134.4 |
| 46   | 40.6 | 21.6 | 06   | 93.6  | 49.8 | 66   | 146.6 | 77.9 | 26   | 199.6 | 106.1 | 86   | 252.6 | 135.5 |
| 47   | 41.5 | 22.1 | 07   | 94.5  | 50.2 | 67   | 147.5 | 78.4 | 27   | 200.4 | 106.6 | 87   | 253.5 | 135.5 |
| 48   | 42.4 | 22.5 | 08   | 95.4  | 50.7 | 68   | 148.3 | 78.9 | 28   | 201.3 | 107.0 | 88   | 254.4 | 136.6 |
| 49   | 43.3 | 23.0 | 09   | 96.2  | 51.2 | 69   | 149.2 | 79.3 | 29   | 202.2 | 107.5 | 89   | 255.3 | 136.6 |
| 50   | 44.2 | 23.5 | 10   | 97.1  | 51.6 | 70   | 150.1 | 79.8 | 30   | 203.1 | 108.0 | 90   | 256.2 | 137.7 |
| 51   | 45.0 | 23.9 | 111  | 98.0  | 52.1 | 171  | 151.0 | 80.3 | 231  | 204.0 | 108.5 | 291  | 257.0 | 137.7 |
| 52   | 45.9 | 24.4 | 12   | 98.9  | 52.6 | 72   | 151.9 | 80.8 | 32   | 204.9 | 108.9 | 92   | 257.8 | 138.8 |
| 53   | 46.8 | 24.9 | 13   | 99.8  | 53.1 | 73   | 152.8 | 81.2 | 33   | 205.7 | 109.4 | 93   | 258.7 | 138.8 |
| 54   | 47.7 | 25.4 | 14   | 100.7 | 53.5 | 74   | 153.6 | 81.7 | 34   | 206.6 | 109.9 | 94   | 259.6 | 139.9 |
| 55   | 48.6 | 25.8 | 15   | 101.5 | 54.0 | 75   | 154.5 | 82.2 | 35   | 207.5 | 110.3 | 95   | 260.5 | 139.9 |
| 56   | 49.4 | 26.3 | 16   | 102.4 | 54.5 | 76   | 155.4 | 82.6 | 36   | 208.4 | 110.8 | 96   | 261.4 | 140.0 |
| 57   | 50.3 | 26.8 | 17   | 103.3 | 54.9 | 77   | 156.3 | 83.1 | 37   | 209.3 | 111.3 | 97   | 262.3 | 141.1 |
| 58   | 51.2 | 27.2 | 18   | 104.2 | 55.4 | 78   | 157.2 | 83.6 | 38   | 210.2 | 111.7 | 98   | 263.2 | 141.1 |
| 59   | 52.1 | 27.7 | 19   | 105.1 | 55.9 | 79   | 158.1 | 84.0 | 39   | 211.0 | 112.2 | 99   | 264.1 | 142.2 |
| 60   | 53.0 | 28.2 | 120  | 106.0 | 56.3 | 180  | 158.9 | 84.5 | 240  | 211.9 | 112.7 | 300  | 264.9 | 142.2 |
| Dist | Dep  | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat  | Dist | Dep   | Lat   | Dist | Dep   | Lat   |

for 62 Degrees.

TABLE III. Difference of Latitude and Departure for 29 Degrees.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep   | Dist | Lat.  | Dep   |
|------|------|------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|
| 1    | 00.9 | 00.5 | 61   | 53.4  | 29.6 | 121  | 105.8 | 58.7 | 181  | 158.3 | 87.7  | 241  | 210.8 | 116.8 |
| 2    | 01.7 | 01.0 | 62   | 54.2  | 30.1 | 22   | 106.7 | 59.1 | 82   | 159.2 | 88.2  | 42   | 211.7 | 117.3 |
| 3    | 02.6 | 01.5 | 63   | 55.1  | 30.5 | 23   | 107.6 | 59.6 | 83   | 160.1 | 88.7  | 43   | 212.5 | 117.8 |
| 4    | 03.5 | 01.9 | 64   | 56.0  | 31.0 | 24   | 108.5 | 60.1 | 84   | 160.9 | 89.2  | 44   | 213.4 | 118.3 |
| 5    | 04.4 | 02.4 | 65   | 56.8  | 31.5 | 25   | 109.3 | 60.6 | 85   | 161.8 | 89.7  | 45   | 214.3 | 118.8 |
| 6    | 05.2 | 02.9 | 66   | 57.7  | 32.0 | 26   | 110.2 | 61.1 | 86   | 162.7 | 90.2  | 46   | 215.2 | 119.3 |
| 7    | 06.1 | 03.4 | 67   | 58.6  | 32.5 | 27   | 111.1 | 61.6 | 87   | 163.6 | 90.7  | 47   | 216.0 | 119.7 |
| 8    | 07.0 | 03.9 | 68   | 59.5  | 33.0 | 28   | 111.9 | 62.1 | 88   | 164.4 | 91.1  | 48   | 216.9 | 120.2 |
| 9    | 07.9 | 04.4 | 69   | 60.3  | 33.5 | 29   | 112.8 | 62.5 | 89   | 165.3 | 91.6  | 49   | 217.8 | 120.7 |
| 10   | 08.7 | 04.8 | 70   | 61.2  | 33.9 | 30   | 113.7 | 63.0 | 90   | 166.2 | 92.1  | 50   | 218.7 | 121.2 |
| 11   | 09.6 | 05.3 | 71   | 62.1  | 34.4 | 131  | 114.6 | 63.5 | 191  | 167.0 | 92.6  | 251  | 219.5 | 121.7 |
| 12   | 10.5 | 05.8 | 72   | 63.0  | 34.9 | 32   | 115.4 | 64.0 | 92   | 167.9 | 93.1  | 52   | 220.4 | 122.2 |
| 13   | 11.4 | 06.3 | 73   | 63.8  | 35.4 | 33   | 116.3 | 64.5 | 93   | 168.8 | 93.6  | 53   | 221.3 | 122.7 |
| 14   | 12.2 | 06.8 | 74   | 64.7  | 35.9 | 34   | 117.2 | 65.0 | 94   | 169.7 | 94.1  | 54   | 222.2 | 123.1 |
| 15   | 13.1 | 07.3 | 75   | 65.6  | 36.4 | 35   | 118.1 | 65.4 | 95   | 170.5 | 94.5  | 55   | 223.0 | 123.6 |
| 16   | 14.0 | 07.8 | 76   | 66.5  | 36.8 | 36   | 118.9 | 65.9 | 96   | 171.4 | 95.0  | 56   | 223.9 | 124.1 |
| 17   | 14.9 | 08.2 | 77   | 67.3  | 37.3 | 37   | 119.8 | 66.4 | 97   | 172.3 | 95.5  | 57   | 224.8 | 124.6 |
| 18   | 15.7 | 08.7 | 78   | 68.2  | 37.8 | 38   | 120.7 | 66.9 | 98   | 173.2 | 96.0  | 58   | 225.6 | 125.1 |
| 19   | 16.6 | 09.2 | 79   | 69.1  | 38.3 | 39   | 121.6 | 67.4 | 99   | 174.0 | 96.5  | 59   | 226.5 | 125.6 |
| 20   | 17.5 | 09.7 | 80   | 70.0  | 38.8 | 40   | 122.4 | 67.9 | 200  | 174.9 | 97.0  | 60   | 227.4 | 126.0 |
| 21   | 18.4 | 10.2 | 81   | 70.8  | 39.3 | 141  | 123.3 | 68.4 | 201  | 175.8 | 97.4  | 261  | 228.3 | 126.5 |
| 22   | 19.2 | 10.7 | 82   | 71.7  | 39.8 | 42   | 124.2 | 68.9 | 02   | 176.7 | 97.9  | 02   | 229.1 | 127.0 |
| 23   | 20.1 | 11.2 | 83   | 72.6  | 40.2 | 43   | 125.1 | 69.3 | 03   | 177.5 | 98.4  | 63   | 230.0 | 127.5 |
| 24   | 21.0 | 11.6 | 84   | 73.5  | 40.7 | 44   | 125.9 | 69.8 | 04   | 178.4 | 98.9  | 65   | 230.9 | 128.0 |
| 25   | 21.9 | 12.1 | 85   | 74.3  | 41.2 | 45   | 126.8 | 70.3 | 05   | 179.3 | 99.4  | 65   | 231.8 | 128.5 |
| 26   | 22.7 | 12.6 | 86   | 75.2  | 41.7 | 46   | 127.7 | 70.8 | 06   | 180.2 | 99.9  | 66   | 232.6 | 129.0 |
| 27   | 23.6 | 13.1 | 87   | 76.1  | 42.2 | 47   | 128.6 | 71.3 | 07   | 181.0 | 100.4 | 67   | 233.5 | 129.4 |
| 28   | 24.5 | 13.6 | 88   | 77.0  | 42.7 | 48   | 129.4 | 71.8 | 08   | 181.9 | 100.8 | 68   | 234.4 | 129.9 |
| 29   | 25.4 | 14.1 | 89   | 77.8  | 43.1 | 49   | 130.3 | 72.2 | 09   | 182.8 | 101.3 | 69   | 235.3 | 130.4 |
| 30   | 26.2 | 14.5 | 90   | 78.7  | 43.6 | 50   | 131.2 | 72.7 | 10   | 183.7 | 101.8 | 70   | 236.1 | 130.9 |
| 31   | 27.1 | 15.0 | 91   | 79.6  | 44.1 | 151  | 132.1 | 73.2 | 211  | 184.5 | 102.3 | 271  | 237.0 | 131.4 |
| 32   | 28.0 | 15.5 | 92   | 80.5  | 44.6 | 52   | 132.9 | 73.7 | 12   | 185.4 | 102.8 | 72   | 237.9 | 131.9 |
| 33   | 28.9 | 16.0 | 93   | 81.3  | 45.1 | 53   | 133.8 | 74.2 | 13   | 186.3 | 103.3 | 73   | 238.8 | 132.4 |
| 34   | 29.7 | 16.5 | 94   | 82.2  | 45.6 | 54   | 134.7 | 74.7 | 14   | 187.2 | 103.7 | 74   | 239.6 | 132.8 |
| 35   | 30.6 | 17.0 | 95   | 83.1  | 46.1 | 55   | 135.6 | 75.1 | 15   | 188.0 | 104.2 | 75   | 240.5 | 133.3 |
| 36   | 31.5 | 17.5 | 96   | 84.0  | 46.5 | 56   | 136.4 | 75.6 | 16   | 188.9 | 104.7 | 76   | 241.4 | 133.8 |
| 37   | 32.4 | 17.9 | 97   | 84.8  | 47.0 | 57   | 137.3 | 76.1 | 17   | 189.8 | 105.2 | 77   | 242.3 | 134.3 |
| 38   | 33.2 | 18.4 | 98   | 85.7  | 47.5 | 58   | 138.2 | 76.6 | 18   | 190.7 | 105.7 | 78   | 243.1 | 134.8 |
| 39   | 34.1 | 18.9 | 99   | 86.6  | 48.0 | 59   | 139.1 | 77.1 | 19   | 191.5 | 106.2 | 79   | 244.0 | 135.3 |
| 40   | 35.0 | 19.4 | 100  | 87.5  | 48.5 | 60   | 139.9 | 77.6 | 20   | 192.4 | 106.7 | 80   | 244.9 | 135.7 |
| 41   | 35.9 | 19.9 | 101  | 88.3  | 49.0 | 161  | 140.8 | 78.1 | 221  | 193.3 | 107.1 | 281  | 245.8 | 136.2 |
| 42   | 36.7 | 20.4 | 02   | 89.2  | 49.4 | 62   | 141.7 | 78.5 | 22   | 194.2 | 107.6 | 82   | 246.6 | 136.7 |
| 43   | 37.6 | 20.8 | 03   | 90.1  | 49.9 | 63   | 142.6 | 79.0 | 23   | 195.0 | 108.1 | 83   | 247.5 | 137.2 |
| 44   | 38.5 | 21.3 | 04   | 91.0  | 50.4 | 64   | 143.4 | 79.5 | 24   | 195.9 | 108.6 | 84   | 248.4 | 137.7 |
| 45   | 39.4 | 21.8 | 05   | 91.8  | 50.9 | 65   | 144.3 | 80.0 | 25   | 196.8 | 109.1 | 85   | 249.3 | 138.2 |
| 46   | 40.2 | 22.3 | 06   | 92.7  | 51.4 | 66   | 145.2 | 80.5 | 26   | 197.7 | 109.6 | 86   | 250.1 | 138.7 |
| 47   | 41.1 | 22.8 | 07   | 93.6  | 51.9 | 67   | 146.1 | 81.0 | 27   | 198.5 | 110.0 | 87   | 251.0 | 139.1 |
| 48   | 42.0 | 23.3 | 08   | 94.5  | 52.4 | 68   | 146.9 | 81.4 | 28   | 199.4 | 110.5 | 88   | 251.9 | 139.6 |
| 49   | 42.9 | 23.8 | 09   | 95.3  | 52.8 | 69   | 147.8 | 81.9 | 29   | 200.3 | 111.0 | 89   | 252.8 | 140.1 |
| 50   | 43.7 | 24.2 | 10   | 96.2  | 53.3 | 70   | 148.7 | 82.4 | 30   | 201.2 | 111.5 | 90   | 253.6 | 140.6 |
| 51   | 44.6 | 24.7 | 111  | 97.1  | 53.8 | 171  | 149.6 | 82.9 | 231  | 202.0 | 112.0 | 291  | 254.5 | 141.1 |
| 52   | 45.5 | 25.2 | 12   | 98.0  | 54.3 | 72   | 150.4 | 83.4 | 32   | 202.9 | 112.5 | 92   | 255.4 | 141.6 |
| 53   | 46.4 | 25.7 | 13   | 98.8  | 54.8 | 73   | 151.3 | 83.9 | 33   | 203.8 | 113.0 | 93   | 256.3 | 142.1 |
| 54   | 47.2 | 26.2 | 14   | 99.7  | 55.3 | 74   | 152.2 | 84.4 | 34   | 204.7 | 113.4 | 94   | 257.1 | 142.5 |
| 55   | 48.1 | 26.7 | 15   | 100.6 | 55.8 | 75   | 153.1 | 84.8 | 35   | 205.5 | 113.9 | 95   | 258.0 | 143.0 |
| 56   | 49.0 | 27.1 | 16   | 101.5 | 56.2 | 76   | 153.9 | 85.3 | 36   | 206.4 | 114.4 | 96   | 258.9 | 143.5 |
| 57   | 49.9 | 27.6 | 17   | 102.3 | 56.7 | 77   | 154.8 | 85.8 | 37   | 207.3 | 114.9 | 97   | 259.8 | 144.0 |
| 58   | 50.7 | 28.1 | 18   | 103.2 | 57.2 | 78   | 155.7 | 86.3 | 38   | 208.2 | 115.4 | 98   | 260.6 | 144.5 |
| 59   | 51.6 | 28.6 | 19   | 104.1 | 57.7 | 79   | 156.6 | 86.8 | 39   | 209.0 | 115.9 | 99   | 261.5 | 145.0 |
| 60   | 52.5 | 29.1 | 120  | 105.0 | 58.2 | 180  | 157.4 | 87.3 | 240  | 209.9 | 116.4 | 300  | 262.4 | 145.4 |

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for 61 Degrees

TABLE III. Difference of Latitude and Departure for 30 Degrees.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep   | Dist | Lat.  | Dep   |
|------|------|------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|
| 1    | 00.9 | 00.5 | 61   | 52.8  | 30.5 | 121  | 104.8 | 60.5 | 181  | 156.7 | 90.5  | 241  | 208.7 | 120.5 |
| 2    | 01.7 | 01.0 | 62   | 53.7  | 31.0 | 22   | 105.7 | 61.0 | 82   | 157.6 | 91.0  | 42   | 209.6 | 121.0 |
| 3    | 02.6 | 01.5 | 63   | 54.6  | 31.5 | 23   | 106.5 | 61.5 | 83   | 158.5 | 91.5  | 43   | 210.4 | 121.5 |
| 4    | 03.5 | 02.0 | 64   | 55.4  | 32.0 | 24   | 107.4 | 62.0 | 84   | 159.3 | 92.0  | 44   | 211.3 | 122.0 |
| 5    | 04.3 | 02.5 | 65   | 56.3  | 32.5 | 25   | 108.3 | 62.5 | 85   | 160.2 | 92.5  | 45   | 212.2 | 122.5 |
| 6    | 05.2 | 03.0 | 66   | 57.2  | 33.0 | 26   | 109.1 | 63.0 | 86   | 161.1 | 93.0  | 46   | 213.0 | 123.0 |
| 7    | 06.1 | 03.5 | 67   | 58.0  | 33.5 | 27   | 110.0 | 63.5 | 87   | 161.9 | 93.5  | 47   | 213.9 | 123.5 |
| 8    | 06.9 | 04.0 | 68   | 58.9  | 34.0 | 28   | 110.8 | 64.0 | 88   | 162.8 | 94.0  | 48   | 214.8 | 124.0 |
| 9    | 07.8 | 04.5 | 69   | 59.8  | 34.5 | 29   | 111.7 | 64.5 | 89   | 163.7 | 94.5  | 49   | 215.6 | 124.5 |
| 10   | 08.7 | 05.0 | 70   | 60.6  | 35.0 | 30   | 112.6 | 65.0 | 90   | 164.5 | 95.0  | 50   | 216.5 | 125.0 |
| 11   | 09.5 | 05.5 | 71   | 61.5  | 35.5 | 31   | 113.4 | 65.5 | 191  | 165.4 | 95.5  | 251  | 217.4 | 125.5 |
| 12   | 10.4 | 06.0 | 72   | 62.4  | 36.0 | 32   | 114.3 | 66.0 | 92   | 166.3 | 96.0  | 52   | 218.2 | 126.0 |
| 13   | 11.3 | 06.5 | 73   | 63.2  | 36.5 | 33   | 115.2 | 66.5 | 93   | 167.1 | 96.5  | 53   | 219.1 | 126.5 |
| 14   | 12.1 | 07.0 | 74   | 64.1  | 37.0 | 34   | 116.0 | 67.0 | 94   | 168.0 | 97.0  | 54   | 220.0 | 127.0 |
| 15   | 13.0 | 07.5 | 75   | 65.0  | 37.5 | 35   | 116.9 | 67.5 | 95   | 168.9 | 97.5  | 55   | 220.8 | 127.5 |
| 16   | 13.9 | 08.0 | 76   | 65.8  | 38.0 | 36   | 117.8 | 68.0 | 96   | 169.7 | 98.0  | 56   | 221.7 | 128.0 |
| 17   | 14.7 | 08.5 | 77   | 66.7  | 38.5 | 37   | 118.6 | 68.5 | 97   | 170.6 | 98.5  | 57   | 222.6 | 128.5 |
| 18   | 15.6 | 09.0 | 78   | 67.5  | 39.0 | 38   | 119.5 | 69.0 | 98   | 171.5 | 99.0  | 58   | 223.4 | 129.0 |
| 19   | 16.5 | 09.5 | 79   | 68.4  | 39.5 | 39   | 120.4 | 69.5 | 99   | 172.3 | 99.5  | 59   | 224.3 | 129.5 |
| 20   | 17.3 | 10.0 | 80   | 69.3  | 40.0 | 40   | 121.2 | 70.0 | 200  | 173.2 | 100.0 | 60   | 225.2 | 130.0 |
| 21   | 18.2 | 10.5 | 81   | 70.1  | 40.5 | 141  | 122.1 | 70.5 | 201  | 174.1 | 100.5 | 261  | 226.0 | 130.5 |
| 22   | 19.1 | 11.0 | 82   | 71.0  | 41.0 | 42   | 123.0 | 71.0 | 02   | 174.9 | 101.0 | 62   | 226.9 | 131.0 |
| 23   | 19.9 | 11.5 | 83   | 71.9  | 41.5 | 43   | 123.8 | 71.5 | 03   | 175.8 | 101.5 | 63   | 227.8 | 131.5 |
| 24   | 20.8 | 12.0 | 84   | 72.7  | 42.0 | 44   | 124.7 | 72.0 | 04   | 176.7 | 102.0 | 64   | 228.6 | 132.0 |
| 25   | 21.7 | 12.5 | 85   | 73.6  | 42.5 | 45   | 125.6 | 72.5 | 05   | 177.5 | 102.5 | 65   | 229.5 | 132.5 |
| 26   | 22.5 | 13.0 | 86   | 74.5  | 43.0 | 46   | 126.4 | 73.0 | 06   | 178.4 | 103.0 | 66   | 230.4 | 133.0 |
| 27   | 23.4 | 13.5 | 87   | 75.3  | 43.5 | 47   | 127.3 | 73.5 | 07   | 179.3 | 103.5 | 67   | 231.2 | 133.5 |
| 28   | 24.2 | 14.0 | 88   | 76.2  | 44.0 | 48   | 128.2 | 74.0 | 08   | 180.1 | 104.0 | 68   | 232.1 | 134.0 |
| 29   | 25.1 | 14.5 | 89   | 77.1  | 44.5 | 49   | 129.0 | 74.5 | 09   | 181.0 | 104.5 | 69   | 233.0 | 134.5 |
| 30   | 26.0 | 15.0 | 90   | 77.9  | 45.0 | 50   | 129.9 | 75.0 | 10   | 181.9 | 105.0 | 70   | 233.8 | 135.0 |
| 31   | 26.8 | 15.5 | 91   | 78.8  | 45.5 | 151  | 130.8 | 75.5 | 211  | 182.7 | 105.5 | 271  | 234.7 | 135.5 |
| 32   | 27.7 | 16.0 | 92   | 79.7  | 46.0 | 52   | 131.7 | 76.0 | 12   | 183.6 | 106.0 | 72   | 235.6 | 136.0 |
| 33   | 28.6 | 16.5 | 93   | 80.5  | 46.5 | 53   | 132.5 | 76.5 | 13   | 184.5 | 106.5 | 73   | 236.4 | 136.5 |
| 34   | 29.4 | 17.0 | 94   | 81.4  | 47.0 | 54   | 133.4 | 77.0 | 14   | 185.3 | 107.0 | 74   | 237.3 | 137.0 |
| 35   | 30.3 | 17.5 | 95   | 82.3  | 47.5 | 55   | 134.2 | 77.5 | 15   | 186.2 | 107.5 | 75   | 238.2 | 137.5 |
| 36   | 31.2 | 18.0 | 96   | 83.1  | 48.0 | 56   | 135.1 | 78.0 | 16   | 187.1 | 108.0 | 76   | 239.0 | 138.0 |
| 37   | 32.0 | 18.5 | 97   | 84.0  | 48.5 | 57   | 136.0 | 78.5 | 17   | 187.9 | 108.5 | 77   | 239.9 | 138.5 |
| 38   | 32.9 | 19.0 | 98   | 84.9  | 49.0 | 58   | 136.8 | 79.0 | 18   | 188.8 | 109.0 | 78   | 240.7 | 139.0 |
| 39   | 33.8 | 19.5 | 99   | 85.7  | 49.5 | 59   | 137.7 | 79.5 | 19   | 189.7 | 109.5 | 79   | 241.6 | 139.5 |
| 40   | 34.6 | 20.0 | 100  | 86.6  | 50.0 | 60   | 138.6 | 80.0 | 20   | 190.5 | 110.0 | 80   | 242.5 | 140.0 |
| 41   | 35.5 | 20.5 | 101  | 87.5  | 50.5 | 161  | 139.4 | 80.5 | 221  | 191.4 | 110.5 | 281  | 243.3 | 140.5 |
| 42   | 36.4 | 21.0 | 02   | 88.3  | 51.0 | 62   | 140.3 | 81.0 | 22   | 192.3 | 111.0 | 82   | 244.2 | 141.0 |
| 43   | 37.2 | 21.5 | 03   | 89.2  | 51.5 | 63   | 141.2 | 81.5 | 23   | 193.1 | 111.5 | 83   | 245.1 | 141.5 |
| 44   | 38.1 | 22.0 | 04   | 90.1  | 52.0 | 64   | 142.0 | 82.0 | 24   | 194.0 | 112.0 | 84   | 245.9 | 142.0 |
| 45   | 39.0 | 22.5 | 05   | 90.9  | 52.5 | 65   | 142.9 | 82.5 | 25   | 194.9 | 112.5 | 85   | 246.8 | 142.5 |
| 46   | 39.8 | 23.0 | 06   | 91.8  | 53.0 | 66   | 143.8 | 83.0 | 26   | 195.7 | 113.0 | 86   | 247.7 | 143.0 |
| 47   | 40.7 | 23.5 | 07   | 92.7  | 53.5 | 67   | 144.6 | 83.5 | 27   | 196.6 | 113.5 | 87   | 248.5 | 143.5 |
| 48   | 41.5 | 24.0 | 08   | 93.5  | 54.0 | 68   | 145.5 | 84.0 | 28   | 197.4 | 114.0 | 88   | 249.4 | 144.0 |
| 49   | 42.4 | 24.5 | 09   | 94.4  | 54.5 | 69   | 146.4 | 84.5 | 29   | 198.3 | 114.5 | 89   | 250.3 | 144.5 |
| 50   | 43.3 | 25.0 | 10   | 95.3  | 55.0 | 70   | 147.2 | 85.0 | 30   | 199.2 | 115.0 | 90   | 251.1 | 145.0 |
| 51   | 44.2 | 25.5 | 111  | 96.1  | 55.5 | 171  | 148.1 | 85.5 | 231  | 200.0 | 115.5 | 291  | 252.0 | 145.5 |
| 52   | 45.0 | 26.0 | 12   | 97.0  | 56.0 | 72   | 149.0 | 86.0 | 32   | 200.9 | 116.0 | 92   | 252.9 | 146.0 |
| 53   | 45.9 | 26.5 | 13   | 97.9  | 56.5 | 73   | 149.8 | 86.5 | 33   | 201.8 | 116.5 | 93   | 253.7 | 146.5 |
| 54   | 46.8 | 27.0 | 14   | 98.7  | 57.0 | 74   | 150.7 | 87.0 | 34   | 202.6 | 117.0 | 94   | 254.6 | 147.0 |
| 55   | 47.6 | 27.5 | 15   | 99.6  | 57.5 | 75   | 151.6 | 87.5 | 35   | 203.5 | 117.5 | 95   | 255.5 | 147.5 |
| 56   | 48.5 | 28.0 | 16   | 100.5 | 58.0 | 76   | 152.4 | 88.0 | 36   | 204.4 | 118.0 | 96   | 256.3 | 148.0 |
| 57   | 49.4 | 28.5 | 17   | 101.3 | 58.5 | 77   | 153.3 | 88.5 | 37   | 205.2 | 118.5 | 97   | 257.2 | 148.5 |
| 58   | 50.2 | 29.0 | 18   | 102.2 | 59.0 | 78   | 154.1 | 89.0 | 38   | 206.1 | 119.0 | 98   | 258.1 | 149.0 |
| 59   | 51.1 | 29.5 | 19   | 103.1 | 59.5 | 79   | 155.0 | 89.5 | 39   | 207.0 | 119.5 | 99   | 258.9 | 149.5 |
| 60   | 52.0 | 30.0 | 120  | 103.9 | 60.0 | 180  | 155.9 | 90.0 | 240  | 207.8 | 120.0 | 300  | 259.8 | 150.0 |
| Dist | Dep  | Lat. | Dist | Dep   | Lat. | Dist | Dep   | Lat. | Dist | Dep   | Lat.  | Dist | Dep   | Lat.  |

for 60 Degrees.



TABLE III. Difference of Latitude and Departure for 31 Degrees.

| Dep. | Lat. | Dep. | Lat. | Dep. | Lat.  | Dep. | Lat. | Dep.  | Lat. | Dep. | Lat.  | Dep.  | Lat. | Dep.  |       |
|------|------|------|------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|
| 120. | 1    | 00.9 | 00.5 | 61   | 52.3  | 31.4 | 121  | 103.7 | 62.3 | 181  | 155.1 | 93.2  | 241  | 206.5 | 124.1 |
| 121. | 2    | 01.7 | 01.0 | 62   | 53.1  | 31.9 | 22   | 104.6 | 62.8 | 82   | 156.0 | 93.7  | 42   | 207.4 | 124.6 |
| 121. | 3    | 02.6 | 01.5 | 63   | 54.0  | 32.4 | 23   | 105.4 | 63.3 | 83   | 156.8 | 94.2  | 43   | 208.3 | 125.1 |
| 122. | 4    | 03.4 | 02.1 | 64   | 54.8  | 33.0 | 24   | 106.3 | 63.9 | 84   | 157.7 | 94.8  | 44   | 209.1 | 125.6 |
| 122. | 5    | 04.3 | 02.6 | 65   | 55.7  | 33.5 | 25   | 107.1 | 64.4 | 85   | 158.5 | 95.3  | 45   | 210.0 | 126.2 |
| 123. | 6    | 05.1 | 03.1 | 66   | 56.6  | 34.0 | 26   | 108.0 | 64.9 | 86   | 159.4 | 95.8  | 46   | 210.8 | 126.7 |
| 123. | 7    | 06.0 | 03.6 | 67   | 57.4  | 34.5 | 27   | 108.8 | 65.4 | 87   | 160.3 | 96.3  | 47   | 211.7 | 127.2 |
| 124. | 8    | 06.9 | 04.1 | 68   | 58.3  | 35.0 | 28   | 109.7 | 65.9 | 88   | 161.1 | 96.8  | 48   | 212.5 | 127.7 |
| 124. | 9    | 07.7 | 04.6 | 69   | 59.1  | 35.5 | 29   | 110.6 | 66.4 | 89   | 162.0 | 97.3  | 49   | 213.4 | 128.2 |
| 125. | 10   | 08.6 | 05.2 | 70   | 60.0  | 36.1 | 30   | 111.4 | 67.0 | 90   | 162.8 | 97.9  | 50   | 214.3 | 128.8 |
| 125. | 11   | 09.4 | 05.7 | 71   | 60.8  | 36.6 | 131  | 112.3 | 67.5 | 191  | 163.7 | 98.4  | 251  | 215.1 | 129.3 |
| 126. | 12   | 10.3 | 06.2 | 72   | 61.7  | 37.1 | 32   | 113.1 | 68.0 | 92   | 164.5 | 98.9  | 52   | 216.0 | 129.8 |
| 126. | 13   | 11.1 | 06.7 | 73   | 62.6  | 37.6 | 33   | 114.0 | 68.5 | 93   | 165.4 | 99.4  | 53   | 216.8 | 130.3 |
| 127. | 14   | 12.0 | 07.2 | 74   | 63.4  | 38.1 | 34   | 114.8 | 69.0 | 94   | 166.3 | 99.9  | 54   | 217.7 | 130.8 |
| 127. | 15   | 12.9 | 07.7 | 75   | 64.3  | 38.6 | 35   | 115.7 | 69.5 | 95   | 167.1 | 100.4 | 55   | 218.5 | 131.3 |
| 128. | 16   | 13.7 | 08.2 | 76   | 65.1  | 39.1 | 36   | 116.6 | 70.0 | 96   | 168.0 | 100.9 | 56   | 219.4 | 131.8 |
| 128. | 17   | 14.6 | 08.8 | 77   | 66.0  | 39.7 | 37   | 117.4 | 70.6 | 97   | 168.8 | 101.5 | 57   | 220.2 | 132.4 |
| 129. | 18   | 15.4 | 09.3 | 78   | 66.8  | 40.2 | 38   | 118.3 | 71.1 | 98   | 169.7 | 102.0 | 58   | 221.1 | 132.9 |
| 129. | 19   | 16.3 | 09.8 | 79   | 67.7  | 40.7 | 39   | 119.1 | 71.6 | 99   | 170.5 | 102.5 | 59   | 222.1 | 133.4 |
| 130. | 20   | 17.1 | 10.3 | 80   | 68.6  | 41.2 | 40   | 120.0 | 72.1 | 200  | 171.4 | 103.0 | 60   | 222.8 | 133.9 |
| 130. | 21   | 18.0 | 10.8 | 81   | 69.4  | 41.7 | 141  | 120.8 | 72.6 | 201  | 172.3 | 103.5 | 261  | 223.7 | 134.4 |
| 131. | 22   | 18.9 | 11.3 | 82   | 70.3  | 42.2 | 42   | 121.7 | 73.1 | 02   | 173.1 | 104.0 | 62   | 224.5 | 134.9 |
| 131. | 23   | 19.7 | 11.8 | 83   | 71.1  | 42.7 | 43   | 122.6 | 73.6 | 03   | 174.0 | 104.5 | 63   | 225.4 | 135.4 |
| 132. | 24   | 20.6 | 12.4 | 84   | 72.0  | 43.3 | 44   | 123.4 | 74.2 | 04   | 174.8 | 105.0 | 64   | 226.2 | 136.0 |
| 132. | 25   | 21.4 | 12.9 | 85   | 72.8  | 43.8 | 45   | 124.3 | 74.7 | 05   | 175.7 | 105.6 | 65   | 227.1 | 136.5 |
| 133. | 26   | 22.3 | 13.4 | 86   | 73.7  | 44.3 | 46   | 125.1 | 75.2 | 06   | 176.5 | 106.1 | 66   | 228.0 | 137.0 |
| 133. | 27   | 23.1 | 13.9 | 87   | 74.6  | 44.8 | 47   | 126.0 | 75.7 | 07   | 177.4 | 106.6 | 67   | 228.8 | 137.5 |
| 134. | 28   | 24.0 | 14.4 | 88   | 75.4  | 45.3 | 48   | 126.8 | 76.2 | 08   | 178.3 | 107.1 | 68   | 229.7 | 138.0 |
| 134. | 29   | 24.9 | 14.9 | 89   | 76.3  | 45.8 | 49   | 127.7 | 76.7 | 09   | 179.1 | 107.6 | 69   | 230.5 | 138.5 |
| 135. | 30   | 25.7 | 15.4 | 90   | 77.1  | 46.4 | 50   | 128.6 | 77.3 | 10   | 180.0 | 108.2 | 70   | 231.4 | 139.1 |
| 135. | 31   | 26.6 | 16.0 | 91   | 78.0  | 46.9 | 151  | 129.4 | 77.8 | 211  | 180.8 | 108.7 | 271  | 232.2 | 139.6 |
| 136. | 32   | 27.4 | 16.5 | 92   | 78.8  | 47.4 | 52   | 130.3 | 78.3 | 12   | 181.7 | 109.2 | 72   | 233.1 | 140.1 |
| 136. | 33   | 28.3 | 17.0 | 93   | 79.7  | 47.9 | 53   | 131.1 | 78.8 | 13   | 182.5 | 109.7 | 73   | 234.0 | 140.6 |
| 137. | 34   | 29.1 | 17.5 | 94   | 80.6  | 48.4 | 54   | 132.0 | 79.3 | 14   | 183.4 | 110.2 | 74   | 234.8 | 141.1 |
| 137. | 35   | 30.0 | 18.0 | 95   | 81.4  | 48.9 | 55   | 132.8 | 79.8 | 15   | 184.3 | 110.7 | 75   | 235.7 | 141.6 |
| 138. | 36   | 30.9 | 18.5 | 96   | 82.3  | 49.4 | 56   | 133.7 | 80.3 | 16   | 185.1 | 111.2 | 76   | 236.5 | 142.1 |
| 138. | 37   | 31.7 | 19.1 | 97   | 83.1  | 50.0 | 57   | 134.5 | 80.9 | 17   | 186.0 | 111.8 | 77   | 237.4 | 142.7 |
| 139. | 38   | 32.6 | 19.6 | 98   | 84.0  | 50.5 | 58   | 135.4 | 81.4 | 18   | 186.8 | 112.3 | 78   | 238.2 | 143.2 |
| 139. | 39   | 33.4 | 20.1 | 99   | 84.8  | 51.0 | 59   | 136.3 | 81.9 | 19   | 187.7 | 112.8 | 79   | 239.1 | 143.7 |
| 140. | 40   | 34.3 | 20.6 | 100  | 85.7  | 51.5 | 60   | 137.1 | 82.4 | 20   | 188.5 | 113.3 | 80   | 240.0 | 144.2 |
| 140. | 41   | 35.1 | 21.1 | 101  | 86.6  | 52.0 | 161  | 138.0 | 82.9 | 221  | 189.4 | 113.8 | 281  | 240.8 | 144.7 |
| 141. | 42   | 36.0 | 21.6 | 02   | 87.4  | 52.5 | 62   | 138.8 | 83.4 | 22   | 190.3 | 114.3 | 82   | 241.7 | 145.2 |
| 141. | 43   | 36.9 | 22.1 | 03   | 88.3  | 53.0 | 63   | 139.7 | 83.9 | 23   | 191.1 | 114.8 | 83   | 242.5 | 145.7 |
| 142. | 44   | 37.7 | 22.6 | 04   | 89.1  | 53.6 | 64   | 140.5 | 84.5 | 24   | 192.0 | 115.4 | 84   | 243.4 | 146.3 |
| 142. | 45   | 38.6 | 23.2 | 05   | 90.0  | 54.1 | 65   | 141.4 | 85.0 | 25   | 192.8 | 115.9 | 85   | 244.2 | 146.8 |
| 143. | 46   | 39.4 | 23.7 | 06   | 90.8  | 54.6 | 66   | 142.3 | 85.5 | 26   | 193.7 | 116.4 | 86   | 245.1 | 147.3 |
| 143. | 47   | 40.3 | 24.2 | 07   | 91.7  | 55.1 | 67   | 143.1 | 86.0 | 27   | 194.5 | 116.9 | 87   | 246.0 | 147.8 |
| 144. | 48   | 41.1 | 24.7 | 08   | 92.6  | 55.6 | 68   | 144.0 | 86.5 | 28   | 195.4 | 117.4 | 88   | 246.8 | 148.3 |
| 144. | 49   | 42.0 | 25.2 | 09   | 93.4  | 56.1 | 69   | 144.8 | 87.0 | 29   | 196.3 | 117.9 | 89   | 247.7 | 148.8 |
| 145. | 50   | 42.9 | 25.8 | 10   | 94.3  | 56.7 | 70   | 145.7 | 87.6 | 30   | 197.1 | 118.5 | 90   | 248.5 | 149.4 |
| 145. | 51   | 43.7 | 26.3 | 111  | 95.1  | 57.2 | 171  | 146.5 | 88.1 | 231  | 198.0 | 119.0 | 291  | 249.4 | 149.8 |
| 146. | 52   | 44.6 | 26.8 | 12   | 96.0  | 57.7 | 72   | 147.4 | 88.6 | 32   | 198.8 | 119.5 | 92   | 250.2 | 150.4 |
| 146. | 53   | 45.4 | 27.3 | 13   | 96.8  | 58.2 | 73   | 148.3 | 89.1 | 33   | 199.7 | 120.0 | 93   | 251.1 | 150.9 |
| 147. | 54   | 46.3 | 27.8 | 14   | 97.7  | 58.7 | 74   | 149.1 | 89.6 | 34   | 200.5 | 120.5 | 94   | 252.0 | 151.4 |
| 147. | 55   | 47.1 | 28.3 | 15   | 98.6  | 59.2 | 75   | 150.0 | 90.1 | 35   | 201.4 | 121.0 | 95   | 252.8 | 151.9 |
| 148. | 56   | 48.0 | 28.8 | 16   | 99.4  | 59.7 | 76   | 150.8 | 90.6 | 36   | 202.3 | 121.5 | 96   | 253.7 | 152.4 |
| 148. | 57   | 48.8 | 29.4 | 17   | 100.3 | 60.3 | 77   | 151.7 | 91.2 | 37   | 203.1 | 122.1 | 97   | 254.5 | 153.0 |
| 149. | 58   | 49.7 | 29.9 | 18   | 101.1 | 60.8 | 78   | 152.5 | 91.7 | 38   | 204.0 | 122.6 | 98   | 255.4 | 153.5 |
| 149. | 59   | 50.6 | 30.4 | 19   | 102.0 | 61.3 | 79   | 153.4 | 92.2 | 39   | 204.8 | 123.1 | 99   | 256.2 | 154.0 |
| 150. | 60   | 51.4 | 30.9 | 120  | 102.8 | 61.8 | 180  | 154.3 | 92.7 | 240  | 205.7 | 123.6 | 300  | 257.1 | 154.5 |
| Lat  | Dist | Dep  | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat. | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  |

for 59 Degrees.

TABLE III. Difference of Latitude and Departure for 32 Degrees.

| Dist | Lat  | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep  | Dist | Lat   | Dep   | Dist | Lat   | Dep   | Dist | Lat   | Dep   |
|------|------|------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.8 | 00.5 | 61   | 51.7  | 32.3 | 121  | 102.6 | 64.1 | 181  | 153.5 | 95.9  | 241  | 204.4 | 127.7 | 301  | 255.3 | 159.0 |
| 2    | 01.7 | 01.1 | 62   | 52.6  | 32.9 | 22   | 103.5 | 64.7 | 82   | 154.3 | 96.5  | 42   | 205.2 | 128.3 | 311  | 256.2 | 159.6 |
| 3    | 02.5 | 01.6 | 63   | 53.4  | 33.4 | 23   | 104.3 | 65.2 | 83   | 155.2 | 97.0  | 43   | 206.1 | 128.8 | 321  | 257.1 | 160.2 |
| 4    | 03.2 | 02.1 | 64   | 54.3  | 33.9 | 24   | 105.2 | 65.7 | 84   | 156.0 | 97.5  | 44   | 206.9 | 129.3 | 331  | 258.0 | 160.8 |
| 5    | 04.4 | 02.6 | 65   | 55.1  | 34.5 | 25   | 106.0 | 66.3 | 85   | 156.9 | 98.1  | 45   | 207.8 | 129.9 | 341  | 258.9 | 161.4 |
| 6    | 05.1 | 03.2 | 66   | 56.0  | 35.0 | 26   | 106.8 | 66.8 | 86   | 157.7 | 98.6  | 46   | 208.6 | 130.4 | 351  | 259.8 | 162.0 |
| 7    | 05.9 | 03.7 | 67   | 56.8  | 35.5 | 27   | 107.7 | 67.3 | 87   | 158.6 | 99.1  | 47   | 209.5 | 130.9 | 361  | 260.7 | 162.6 |
| 8    | 06.8 | 04.2 | 68   | 57.7  | 36.0 | 28   | 108.5 | 67.8 | 88   | 159.4 | 99.6  | 48   | 210.3 | 131.4 | 371  | 261.6 | 163.2 |
| 9    | 07.6 | 04.8 | 69   | 58.5  | 36.6 | 29   | 109.4 | 68.4 | 89   | 160.3 | 100.2 | 49   | 211.2 | 132.0 | 381  | 262.5 | 163.8 |
| 10   | 08.5 | 05.3 | 70   | 59.4  | 37.1 | 30   | 110.2 | 68.9 | 90   | 161.1 | 100.7 | 50   | 212.0 | 132.5 | 391  | 263.4 | 164.4 |
| 11   | 09.3 | 05.8 | 71   | 60.2  | 37.6 | 31   | 111.1 | 69.4 | 191  | 162.0 | 101.2 | 251  | 212.8 | 133.0 | 451  | 264.3 | 165.0 |
| 12   | 10.2 | 06.4 | 72   | 61.1  | 38.2 | 32   | 111.9 | 70.0 | 92   | 162.8 | 101.8 | 52   | 213.7 | 133.6 | 461  | 265.2 | 165.6 |
| 13   | 11.0 | 06.9 | 73   | 61.9  | 38.7 | 33   | 112.8 | 70.5 | 93   | 163.7 | 102.3 | 53   | 214.5 | 134.1 | 471  | 266.1 | 166.2 |
| 14   | 11.9 | 07.4 | 74   | 62.8  | 39.2 | 34   | 113.6 | 71.0 | 94   | 164.5 | 102.8 | 54   | 215.4 | 134.6 | 481  | 267.0 | 166.8 |
| 15   | 12.7 | 08.0 | 75   | 63.6  | 39.8 | 35   | 114.5 | 71.6 | 95   | 165.4 | 103.4 | 55   | 216.2 | 135.2 | 491  | 267.9 | 167.4 |
| 16   | 13.6 | 08.5 | 76   | 64.4  | 40.3 | 36   | 115.3 | 72.1 | 96   | 166.2 | 103.9 | 56   | 217.1 | 135.7 | 501  | 268.8 | 168.0 |
| 17   | 14.4 | 09.0 | 77   | 65.3  | 40.8 | 37   | 116.2 | 72.6 | 97   | 167.1 | 104.4 | 57   | 217.9 | 136.2 | 511  | 269.7 | 168.6 |
| 18   | 15.3 | 09.5 | 78   | 66.1  | 41.3 | 38   | 117.0 | 73.1 | 98   | 167.9 | 104.9 | 58   | 218.8 | 136.7 | 521  | 270.6 | 169.2 |
| 19   | 16.1 | 10.1 | 79   | 67.0  | 41.9 | 39   | 117.9 | 73.7 | 99   | 168.8 | 105.5 | 59   | 219.6 | 137.3 | 531  | 271.5 | 169.8 |
| 20   | 17.0 | 10.6 | 80   | 67.8  | 42.4 | 40   | 118.8 | 74.2 | 200  | 169.6 | 106.0 | 60   | 220.3 | 137.8 | 541  | 272.4 | 170.4 |
| 21   | 17.8 | 11.1 | 81   | 68.7  | 42.9 | 41   | 119.6 | 74.7 | 201  | 170.4 | 106.5 | 261  | 221.3 | 138.3 | 601  | 273.3 | 171.0 |
| 22   | 18.7 | 11.7 | 82   | 69.5  | 43.5 | 42   | 120.4 | 75.3 | 02   | 171.3 | 107.1 | 62   | 222.2 | 138.9 | 611  | 274.2 | 171.6 |
| 23   | 19.5 | 12.2 | 83   | 70.4  | 44.0 | 43   | 121.3 | 75.8 | 03   | 172.1 | 107.6 | 63   | 223.0 | 139.4 | 621  | 275.1 | 172.2 |
| 24   | 20.4 | 12.7 | 84   | 71.2  | 44.5 | 44   | 122.1 | 76.3 | 04   | 173.0 | 108.1 | 64   | 223.9 | 139.9 | 631  | 276.0 | 172.8 |
| 25   | 21.2 | 13.3 | 85   | 72.1  | 45.1 | 45   | 123.0 | 76.9 | 05   | 173.8 | 108.7 | 65   | 224.7 | 140.5 | 641  | 276.9 | 173.4 |
| 26   | 22.0 | 13.8 | 86   | 72.9  | 45.6 | 46   | 123.8 | 77.4 | 06   | 174.7 | 109.2 | 66   | 225.6 | 141.0 | 651  | 277.8 | 174.0 |
| 27   | 22.9 | 14.3 | 87   | 73.8  | 46.1 | 47   | 124.7 | 77.9 | 07   | 175.5 | 109.7 | 67   | 226.4 | 141.5 | 661  | 278.7 | 174.6 |
| 28   | 23.7 | 14.8 | 88   | 74.6  | 46.6 | 48   | 125.5 | 78.4 | 08   | 176.4 | 110.2 | 68   | 227.3 | 142.0 | 671  | 279.6 | 175.2 |
| 29   | 24.6 | 15.4 | 89   | 75.4  | 47.2 | 49   | 126.4 | 79.0 | 09   | 177.2 | 110.8 | 69   | 228.1 | 142.6 | 681  | 280.5 | 175.8 |
| 30   | 25.4 | 15.9 | 90   | 76.3  | 47.7 | 50   | 127.2 | 79.5 | 10   | 178.1 | 111.3 | 70   | 229.0 | 143.1 | 691  | 281.4 | 176.4 |
| 31   | 26.3 | 16.4 | 91   | 77.2  | 48.2 | 51   | 128.0 | 80.0 | 211  | 178.9 | 111.8 | 271  | 229.8 | 143.6 | 751  | 282.3 | 177.0 |
| 32   | 27.1 | 17.0 | 92   | 78.0  | 48.8 | 52   | 128.9 | 80.6 | 12   | 179.8 | 112.4 | 72   | 230.7 | 144.2 | 761  | 283.2 | 177.6 |
| 33   | 28.0 | 17.5 | 93   | 78.9  | 49.3 | 53   | 129.7 | 81.1 | 13   | 180.5 | 112.9 | 73   | 231.5 | 144.7 | 771  | 284.1 | 178.2 |
| 34   | 28.8 | 18.0 | 94   | 79.7  | 49.8 | 54   | 130.6 | 81.6 | 14   | 181.4 | 113.4 | 74   | 232.4 | 145.2 | 781  | 285.0 | 178.8 |
| 35   | 29.7 | 18.6 | 95   | 80.6  | 50.4 | 55   | 131.4 | 82.2 | 15   | 182.3 | 114.0 | 75   | 233.2 | 145.8 | 791  | 285.9 | 179.4 |
| 36   | 30.5 | 19.1 | 96   | 81.4  | 50.9 | 56   | 132.3 | 82.7 | 16   | 183.2 | 114.5 | 76   | 234.0 | 146.3 | 801  | 286.8 | 180.0 |
| 37   | 31.4 | 19.6 | 97   | 82.3  | 51.4 | 57   | 133.1 | 83.2 | 17   | 184.0 | 115.0 | 77   | 234.9 | 146.8 | 811  | 287.7 | 180.6 |
| 38   | 32.2 | 20.1 | 98   | 83.1  | 51.9 | 58   | 134.0 | 83.7 | 18   | 184.9 | 115.5 | 78   | 235.7 | 147.3 | 821  | 288.6 | 181.2 |
| 39   | 33.1 | 20.7 | 99   | 84.0  | 52.5 | 59   | 134.8 | 84.3 | 19   | 185.7 | 116.1 | 79   | 236.6 | 147.9 | 831  | 289.5 | 181.8 |
| 40   | 33.9 | 21.2 | 100  | 84.8  | 53.0 | 60   | 135.7 | 84.8 | 20   | 186.6 | 116.6 | 80   | 237.4 | 148.4 | 841  | 290.4 | 182.4 |
| 41   | 34.8 | 21.7 | 101  | 85.6  | 53.5 | 161  | 136.5 | 85.3 | 221  | 187.4 | 117.1 | 281  | 238.3 | 148.9 | 901  | 291.3 | 183.0 |
| 42   | 35.6 | 22.3 | 02   | 86.5  | 54.1 | 62   | 137.4 | 85.9 | 22   | 188.3 | 117.7 | 82   | 239.1 | 149.5 | 911  | 292.2 | 183.6 |
| 43   | 36.5 | 22.8 | 03   | 87.3  | 54.6 | 63   | 138.2 | 86.4 | 23   | 189.1 | 118.2 | 83   | 240.0 | 150.0 | 921  | 293.1 | 184.2 |
| 44   | 37.3 | 23.3 | 04   | 88.2  | 55.1 | 64   | 139.1 | 86.9 | 24   | 190.0 | 118.7 | 84   | 240.8 | 150.5 | 931  | 294.0 | 184.8 |
| 45   | 38.2 | 23.9 | 05   | 89.0  | 55.7 | 65   | 139.9 | 87.5 | 25   | 190.8 | 119.3 | 85   | 241.7 | 151.1 | 941  | 294.9 | 185.4 |
| 46   | 39.0 | 24.4 | 06   | 89.9  | 56.2 | 66   | 140.8 | 88.0 | 26   | 191.6 | 119.8 | 86   | 242.5 | 151.6 | 951  | 295.8 | 186.0 |
| 47   | 39.9 | 24.9 | 07   | 90.7  | 56.7 | 67   | 141.6 | 88.5 | 27   | 192.5 | 120.3 | 87   | 243.4 | 152.1 | 961  | 296.7 | 186.6 |
| 48   | 40.7 | 25.4 | 08   | 91.6  | 57.2 | 68   | 142.5 | 89.0 | 28   | 193.3 | 120.8 | 88   | 244.2 | 152.6 | 971  | 297.6 | 187.2 |
| 49   | 41.6 | 26.0 | 09   | 92.4  | 57.8 | 69   | 143.3 | 89.6 | 29   | 194.2 | 121.4 | 89   | 245.1 | 153.2 | 981  | 298.5 | 187.8 |
| 50   | 42.4 | 26.5 | 10   | 93.3  | 58.3 | 70   | 144.2 | 90.1 | 30   | 195.0 | 121.9 | 90   | 245.9 | 153.7 | 991  | 299.4 | 188.4 |
| 51   | 43.2 | 27.0 | 111  | 94.1  | 58.8 | 171  | 145.0 | 90.6 | 231  | 195.9 | 122.4 | 291  | 246.8 | 154.2 | 1051 | 300.3 | 189.0 |
| 52   | 44.1 | 27.6 | 12   | 95.0  | 59.4 | 72   | 145.9 | 91.2 | 32   | 196.7 | 123.0 | 92   | 247.6 | 154.8 | 1061 | 301.2 | 189.6 |
| 53   | 44.9 | 28.1 | 13   | 95.8  | 59.9 | 73   | 146.7 | 91.7 | 33   | 197.6 | 123.5 | 93   | 248.5 | 155.3 | 1071 | 302.1 | 190.2 |
| 54   | 45.8 | 28.6 | 14   | 96.7  | 60.4 | 74   | 147.6 | 92.2 | 35   | 198.4 | 124.0 | 94   | 249.3 | 155.8 | 1081 | 303.0 | 190.8 |
| 55   | 46.6 | 29.2 | 15   | 97.5  | 61.0 | 75   | 148.4 | 92.8 | 35   | 199.3 | 124.6 | 95   | 250.2 | 156.4 | 1091 | 303.9 | 191.4 |
| 56   | 47.5 | 29.7 | 16   | 98.4  | 61.5 | 76   | 149.2 | 93.3 | 36   | 200.1 | 125.1 | 96   | 251.0 | 156.9 | 1101 | 304.8 | 192.0 |
| 57   | 48.3 | 30.2 | 17   | 99.2  | 62.0 | 77   | 150.1 | 93.8 | 37   | 201.0 | 125.6 | 97   | 251.9 | 157.4 | 1111 | 305.7 | 192.6 |
| 58   | 49.2 | 30.7 | 18   | 100.1 | 62.5 | 78   | 150.9 | 94.3 | 38   | 201.8 | 126.1 | 98   | 252.7 | 157.9 | 1121 | 306.6 | 193.2 |
| 59   | 50.0 | 31.3 | 19   | 100.9 | 63.1 | 79   | 151.8 | 94.9 | 39   | 202.7 | 126.7 | 99   | 253.6 | 158.5 | 1131 | 307.5 | 193.8 |
| 60   | 50.9 | 31.8 | 120  | 101.8 | 63.6 | 180  | 152.6 | 95.4 | 240  | 203.5 | 127.2 | 300  | 254.4 | 159.0 | 1141 | 308.4 | 194.4 |
| Dist | Dep  | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat  | Dist | Dep.  | Lat   | Dist | Dep.  | Lat   | Dist | Dep.  | Lat   |

for 58 Degrees.

TABLE III. Difference of Latitude and Departure for 33 Degrees.

| Dist | Lat. | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep  | Dist | Lat.  | Dep   | Dist | Lat.  | Dep   |
|------|------|------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|
| 1    | 00.8 | 00.5 | 61   | 51.2  | 33.2 | 121  | 101.5 | 65.9 | 181  | 151.8 | 98.6  | 241  | 202.1 | 131.2 |
| 2    | 01.7 | 01.1 | 62   | 52.0  | 33.8 | 22   | 102.3 | 66.4 | 82   | 152.6 | 99.1  | 42   | 202.9 | 131.8 |
| 3    | 02.5 | 01.6 | 63   | 52.8  | 34.3 | 23   | 103.1 | 67.0 | 83   | 153.5 | 99.7  | 43   | 203.8 | 132.3 |
| 4    | 03.4 | 02.2 | 64   | 53.7  | 34.9 | 24   | 104.0 | 67.5 | 84   | 154.3 | 100.2 | 44   | 204.6 | 132.9 |
| 5    | 04.2 | 02.7 | 65   | 54.5  | 35.4 | 25   | 104.8 | 68.1 | 85   | 155.1 | 100.8 | 45   | 205.5 | 133.4 |
| 6    | 05.0 | 03.3 | 66   | 55.3  | 35.9 | 26   | 105.7 | 68.6 | 86   | 156.0 | 101.3 | 46   | 206.3 | 134.0 |
| 7    | 05.9 | 03.8 | 67   | 56.2  | 36.5 | 27   | 106.5 | 69.2 | 87   | 156.8 | 101.8 | 47   | 207.1 | 134.5 |
| 8    | 06.7 | 04.4 | 68   | 57.0  | 37.0 | 28   | 107.3 | 69.7 | 88   | 157.7 | 102.4 | 48   | 208.0 | 135.1 |
| 9    | 07.5 | 04.9 | 69   | 57.9  | 37.6 | 29   | 108.2 | 70.3 | 89   | 158.5 | 102.9 | 49   | 208.8 | 135.6 |
| 10   | 08.4 | 05.4 | 70   | 58.7  | 38.1 | 30   | 109.0 | 70.8 | 90   | 159.3 | 103.5 | 50   | 209.7 | 136.2 |
| 11   | 09.2 | 06.0 | 71   | 59.5  | 38.7 | 131  | 109.9 | 71.3 | 191  | 160.2 | 104.0 | 251  | 210.5 | 136.7 |
| 12   | 10.1 | 06.5 | 72   | 60.4  | 39.2 | 32   | 110.7 | 71.9 | 92   | 161.0 | 104.6 | 52   | 211.3 | 137.2 |
| 13   | 10.9 | 07.1 | 73   | 61.2  | 39.8 | 33   | 111.5 | 72.4 | 93   | 161.8 | 105.1 | 53   | 212.2 | 137.8 |
| 14   | 11.7 | 07.6 | 74   | 62.1  | 40.3 | 34   | 112.4 | 73.0 | 94   | 162.7 | 105.7 | 54   | 213.0 | 138.3 |
| 15   | 12.6 | 08.2 | 75   | 62.9  | 40.8 | 35   | 113.2 | 73.5 | 95   | 163.5 | 106.2 | 55   | 213.8 | 138.9 |
| 16   | 13.4 | 08.7 | 76   | 63.7  | 41.4 | 36   | 114.0 | 74.1 | 96   | 164.4 | 106.7 | 56   | 214.7 | 139.4 |
| 17   | 14.3 | 09.3 | 77   | 64.6  | 41.9 | 37   | 114.9 | 74.6 | 97   | 165.2 | 107.3 | 57   | 215.5 | 140.0 |
| 18   | 15.1 | 09.8 | 78   | 65.4  | 42.5 | 38   | 115.7 | 75.2 | 98   | 166.0 | 107.8 | 58   | 216.4 | 140.5 |
| 19   | 15.9 | 10.3 | 79   | 66.2  | 43.0 | 39   | 116.6 | 75.7 | 99   | 166.9 | 108.4 | 59   | 217.2 | 141.1 |
| 20   | 16.8 | 10.9 | 80   | 67.1  | 43.6 | 40   | 117.4 | 76.2 | 200  | 167.7 | 108.9 | 60   | 218.0 | 141.6 |
| 21   | 17.6 | 11.4 | 81   | 67.9  | 44.1 | 141  | 118.2 | 76.8 | 201  | 168.6 | 109.5 | 261  | 218.9 | 142.1 |
| 22   | 18.4 | 12.0 | 82   | 68.8  | 44.7 | 42   | 119.1 | 77.3 | 02   | 169.4 | 110.0 | 62   | 219.7 | 142.7 |
| 23   | 19.3 | 12.5 | 83   | 69.6  | 45.2 | 43   | 119.9 | 77.9 | 03   | 170.2 | 110.6 | 63   | 220.6 | 143.2 |
| 24   | 20.1 | 13.1 | 84   | 70.4  | 45.7 | 44   | 120.8 | 78.4 | 04   | 171.1 | 111.1 | 64   | 221.4 | 143.8 |
| 25   | 21.0 | 13.6 | 85   | 71.3  | 46.3 | 45   | 121.6 | 79.0 | 05   | 171.9 | 111.6 | 65   | 222.2 | 144.3 |
| 26   | 21.8 | 14.2 | 86   | 72.1  | 46.8 | 46   | 122.4 | 79.5 | 06   | 172.8 | 112.2 | 66   | 223.1 | 144.9 |
| 27   | 22.6 | 14.7 | 87   | 73.0  | 47.4 | 47   | 123.3 | 80.1 | 07   | 173.6 | 112.7 | 67   | 223.9 | 145.4 |
| 28   | 23.5 | 15.2 | 88   | 73.8  | 47.9 | 48   | 124.1 | 80.6 | 08   | 174.4 | 113.3 | 68   | 224.7 | 146.0 |
| 29   | 24.3 | 15.8 | 89   | 74.6  | 48.5 | 49   | 125.0 | 81.1 | 09   | 175.3 | 113.8 | 69   | 225.6 | 146.5 |
| 30   | 25.2 | 16.3 | 90   | 75.5  | 49.0 | 50   | 125.8 | 81.7 | 10   | 176.1 | 114.4 | 70   | 226.4 | 147.1 |
| 31   | 26.0 | 16.9 | 91   | 76.3  | 49.6 | 151  | 126.6 | 82.2 | 211  | 176.9 | 114.9 | 271  | 227.3 | 147.6 |
| 32   | 26.8 | 17.4 | 92   | 77.2  | 50.1 | 52   | 127.5 | 82.8 | 12   | 177.8 | 115.5 | 72   | 228.1 | 148.1 |
| 33   | 27.7 | 18.0 | 93   | 78.0  | 50.6 | 53   | 128.3 | 83.3 | 13   | 178.6 | 116.0 | 73   | 228.9 | 148.7 |
| 34   | 28.5 | 18.5 | 94   | 78.8  | 51.2 | 54   | 129.1 | 83.9 | 14   | 179.5 | 116.5 | 74   | 229.8 | 149.2 |
| 35   | 29.4 | 19.1 | 95   | 79.7  | 51.7 | 55   | 130.0 | 84.4 | 15   | 180.3 | 117.1 | 75   | 230.6 | 149.8 |
| 36   | 30.2 | 19.6 | 96   | 80.5  | 52.3 | 56   | 130.8 | 85.0 | 16   | 181.1 | 117.6 | 76   | 231.5 | 150.3 |
| 37   | 31.0 | 20.2 | 97   | 81.3  | 52.8 | 57   | 131.7 | 85.5 | 17   | 182.0 | 118.2 | 77   | 232.3 | 150.9 |
| 38   | 31.9 | 20.7 | 98   | 82.2  | 53.4 | 58   | 132.5 | 86.0 | 18   | 182.8 | 118.7 | 78   | 233.1 | 151.4 |
| 39   | 32.7 | 21.2 | 99   | 83.0  | 53.9 | 59   | 133.3 | 86.6 | 19   | 183.7 | 119.3 | 79   | 234.0 | 151.9 |
| 40   | 33.5 | 21.8 | 100  | 83.9  | 54.5 | 60   | 134.2 | 87.1 | 20   | 184.5 | 119.8 | 80   | 234.8 | 152.3 |
| 41   | 34.4 | 22.3 | 101  | 84.7  | 55.0 | 161  | 135.0 | 87.7 | 221  | 185.3 | 120.4 | 281  | 235.6 | 153.0 |
| 42   | 35.2 | 22.9 | 02   | 85.5  | 55.5 | 62   | 135.9 | 88.2 | 22   | 186.2 | 120.9 | 82   | 236.5 | 153.6 |
| 43   | 36.1 | 23.4 | 03   | 86.4  | 56.1 | 63   | 136.7 | 88.8 | 23   | 187.0 | 121.4 | 83   | 237.3 | 154.1 |
| 44   | 36.9 | 24.0 | 04   | 87.2  | 56.6 | 64   | 137.5 | 89.3 | 24   | 187.8 | 122.0 | 84   | 238.2 | 154.7 |
| 45   | 37.7 | 24.5 | 05   | 88.1  | 57.2 | 65   | 138.4 | 89.9 | 25   | 188.7 | 122.5 | 85   | 239.0 | 155.2 |
| 46   | 38.6 | 25.1 | 06   | 88.9  | 57.7 | 66   | 139.2 | 90.4 | 26   | 189.5 | 123.1 | 86   | 239.8 | 155.8 |
| 47   | 39.4 | 25.6 | 07   | 89.7  | 58.3 | 67   | 140.0 | 90.9 | 27   | 190.4 | 123.6 | 87   | 240.7 | 156.3 |
| 48   | 40.3 | 26.1 | 08   | 90.6  | 58.8 | 68   | 140.9 | 91.5 | 28   | 191.2 | 124.2 | 88   | 241.5 | 156.8 |
| 49   | 41.1 | 26.7 | 09   | 91.4  | 59.4 | 69   | 141.7 | 92.0 | 29   | 192.0 | 124.7 | 89   | 242.4 | 157.4 |
| 50   | 41.9 | 27.2 | 10   | 92.2  | 59.9 | 70   | 142.6 | 92.6 | 30   | 192.9 | 125.3 | 90   | 243.2 | 157.9 |
| 51   | 42.8 | 27.8 | 11   | 93.1  | 60.5 | 171  | 143.4 | 93.1 | 231  | 193.7 | 125.8 | 291  | 244.0 | 158.5 |
| 52   | 43.6 | 28.3 | 12   | 93.9  | 61.0 | 72   | 144.2 | 93.7 | 32   | 194.6 | 126.3 | 92   | 244.9 | 159.0 |
| 53   | 44.4 | 28.9 | 13   | 94.8  | 61.5 | 73   | 145.1 | 94.2 | 33   | 195.4 | 126.9 | 93   | 245.7 | 159.6 |
| 54   | 45.3 | 29.4 | 14   | 95.6  | 62.1 | 74   | 145.9 | 94.8 | 34   | 196.2 | 127.4 | 94   | 246.5 | 160.1 |
| 55   | 46.1 | 30.0 | 15   | 96.4  | 62.6 | 75   | 146.8 | 95.3 | 35   | 197.1 | 128.0 | 95   | 247.4 | 160.7 |
| 56   | 47.0 | 30.5 | 16   | 97.3  | 63.2 | 76   | 147.6 | 95.8 | 36   | 197.9 | 128.5 | 96   | 248.2 | 161.2 |
| 57   | 47.8 | 31.0 | 17   | 98.1  | 63.7 | 77   | 148.4 | 96.4 | 37   | 198.7 | 129.1 | 97   | 249.1 | 161.7 |
| 58   | 48.6 | 31.6 | 18   | 99.0  | 64.3 | 78   | 149.3 | 96.9 | 38   | 199.6 | 129.6 | 98   | 249.9 | 162.3 |
| 59   | 49.5 | 32.1 | 19   | 99.8  | 64.8 | 79   | 150.1 | 97.5 | 39   | 200.4 | 130.2 | 99   | 250.7 | 162.8 |
| 60   | 50.4 | 32.7 | 20   | 100.6 | 65.4 | 180  | 150.9 | 98.0 | 40   | 201.3 | 130.7 | 300  | 251.6 | 163.4 |

for 57 Degrees.



TABLE III. Difference of Latitude and Departure for 34 Degrees.

| Dist | Lat  | Dep  | Dist | Lat  | Dep  | Dist | Lat   | Dep   | Dist | Lat   | Dep   | Dist | Lat   | Dep   | Dist | Lat   | Dep   |
|------|------|------|------|------|------|------|-------|-------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.8 | 00.6 | 61   | 50.6 | 34.1 | 121  | 100.3 | 67.7  | 181  | 150.0 | 101.2 | 241  | 199.8 | 134.4 | 301  | 249.6 | 168.8 |
| 2    | 01.7 | 01.1 | 62   | 51.4 | 34.7 | 22   | 101.1 | 68.2  | 82   | 150.9 | 101.8 | 42   | 200.6 | 135.1 | 102  | 250.3 | 169.5 |
| 3    | 02.5 | 01.7 | 63   | 52.2 | 35.2 | 23   | 102.0 | 68.8  | 83   | 151.7 | 102.3 | 43   | 201.4 | 135.4 | 103  | 251.1 | 170.1 |
| 4    | 03.3 | 02.2 | 64   | 53.1 | 35.8 | 24   | 102.8 | 69.3  | 84   | 152.5 | 102.9 | 44   | 202.3 | 136.0 | 104  | 251.9 | 170.7 |
| 5    | 04.1 | 02.8 | 65   | 53.9 | 36.3 | 25   | 103.6 | 69.9  | 85   | 153.4 | 103.5 | 45   | 203.1 | 136.3 | 105  | 252.8 | 171.3 |
| 6    | 05.0 | 03.4 | 66   | 54.7 | 36.9 | 26   | 104.5 | 70.5  | 86   | 154.2 | 104.0 | 46   | 203.9 | 136.7 | 106  | 253.7 | 171.9 |
| 7    | 05.8 | 03.9 | 67   | 55.5 | 37.5 | 27   | 105.3 | 71.0  | 87   | 155.0 | 104.6 | 47   | 204.8 | 137.2 | 107  | 254.5 | 172.5 |
| 8    | 06.6 | 04.5 | 68   | 56.4 | 38.0 | 28   | 106.1 | 71.6  | 88   | 155.9 | 105.1 | 48   | 205.6 | 137.8 | 108  | 255.4 | 173.1 |
| 9    | 07.5 | 05.0 | 69   | 57.2 | 38.6 | 29   | 106.9 | 72.1  | 89   | 156.7 | 105.7 | 49   | 206.4 | 138.1 | 109  | 256.3 | 173.7 |
| 10   | 08.3 | 05.6 | 70   | 58.0 | 39.1 | 30   | 107.8 | 72.7  | 90   | 157.5 | 106.2 | 50   | 207.3 | 138.5 | 110  | 257.2 | 174.3 |
| 11   | 09.1 | 06.2 | 71   | 58.9 | 39.7 | 31   | 108.6 | 73.3  | 91   | 158.3 | 106.8 | 51   | 208.1 | 138.9 | 111  | 258.1 | 174.9 |
| 12   | 09.9 | 06.7 | 72   | 59.7 | 40.3 | 32   | 109.4 | 73.8  | 92   | 159.2 | 107.4 | 52   | 208.9 | 139.3 | 112  | 259.0 | 175.5 |
| 13   | 10.8 | 07.3 | 73   | 60.5 | 40.8 | 33   | 110.3 | 74.4  | 93   | 160.0 | 107.9 | 53   | 209.7 | 139.7 | 113  | 259.9 | 176.1 |
| 14   | 11.6 | 07.8 | 74   | 61.3 | 41.4 | 34   | 111.1 | 74.9  | 94   | 160.8 | 108.5 | 54   | 210.6 | 140.2 | 114  | 260.8 | 176.7 |
| 15   | 12.4 | 08.4 | 75   | 62.2 | 41.9 | 35   | 111.9 | 75.5  | 95   | 161.7 | 109.0 | 55   | 211.4 | 140.6 | 115  | 261.7 | 177.3 |
| 16   | 13.3 | 08.9 | 76   | 63.0 | 42.5 | 36   | 112.7 | 76.1  | 96   | 162.5 | 109.6 | 56   | 212.2 | 141.0 | 116  | 262.6 | 177.9 |
| 17   | 14.1 | 09.5 | 77   | 63.8 | 43.1 | 37   | 113.6 | 76.6  | 97   | 163.3 | 110.2 | 57   | 213.1 | 141.5 | 117  | 263.5 | 178.5 |
| 18   | 14.9 | 10.1 | 78   | 64.7 | 43.6 | 38   | 114.4 | 77.2  | 98   | 164.1 | 110.7 | 58   | 213.9 | 141.9 | 118  | 264.4 | 179.1 |
| 19   | 15.8 | 10.6 | 79   | 65.5 | 44.2 | 39   | 115.2 | 77.7  | 99   | 165.0 | 111.3 | 59   | 214.7 | 142.4 | 119  | 265.3 | 179.7 |
| 20   | 16.6 | 11.2 | 80   | 66.3 | 44.7 | 40   | 116.1 | 78.3  | 200  | 165.8 | 111.8 | 60   | 215.5 | 142.8 | 120  | 266.2 | 180.3 |
| 21   | 17.4 | 11.7 | 81   | 67.1 | 45.3 | 41   | 116.9 | 78.8  | 201  | 166.6 | 112.4 | 61   | 216.4 | 143.3 | 121  | 267.1 | 180.9 |
| 22   | 18.2 | 12.3 | 82   | 68.0 | 45.9 | 42   | 117.7 | 79.4  | 02   | 167.5 | 113.0 | 62   | 217.2 | 143.7 | 122  | 268.0 | 181.5 |
| 23   | 19.1 | 12.9 | 83   | 68.8 | 46.4 | 43   | 118.5 | 80.0  | 03   | 168.3 | 113.5 | 63   | 218.0 | 144.2 | 123  | 268.9 | 182.1 |
| 24   | 19.9 | 13.4 | 84   | 69.6 | 47.0 | 44   | 119.4 | 80.5  | 04   | 169.1 | 114.1 | 64   | 218.9 | 144.7 | 124  | 269.8 | 182.7 |
| 25   | 20.7 | 14.0 | 85   | 70.5 | 47.5 | 45   | 120.2 | 81.1  | 05   | 169.9 | 114.6 | 65   | 219.7 | 145.2 | 125  | 270.7 | 183.3 |
| 26   | 21.6 | 14.5 | 86   | 71.3 | 48.1 | 46   | 121.0 | 81.6  | 06   | 170.8 | 115.2 | 66   | 220.5 | 145.7 | 126  | 271.6 | 183.9 |
| 27   | 22.4 | 15.1 | 87   | 72.1 | 48.7 | 47   | 121.9 | 82.2  | 07   | 171.6 | 115.8 | 67   | 221.3 | 146.2 | 127  | 272.5 | 184.5 |
| 28   | 23.2 | 15.7 | 88   | 73.0 | 49.2 | 48   | 122.7 | 82.8  | 08   | 172.4 | 116.3 | 68   | 222.2 | 146.7 | 128  | 273.4 | 185.1 |
| 29   | 24.0 | 16.2 | 89   | 73.8 | 49.8 | 49   | 123.5 | 83.3  | 09   | 173.3 | 116.9 | 69   | 223.0 | 147.2 | 129  | 274.3 | 185.7 |
| 30   | 24.9 | 16.8 | 90   | 74.6 | 50.3 | 50   | 124.4 | 83.9  | 10   | 174.1 | 117.4 | 70   | 223.8 | 147.7 | 130  | 275.2 | 186.3 |
| 31   | 25.7 | 17.3 | 91   | 75.4 | 50.9 | 51   | 125.2 | 84.4  | 211  | 174.9 | 118.0 | 71   | 224.7 | 148.2 | 131  | 276.1 | 186.9 |
| 32   | 26.5 | 17.9 | 92   | 76.3 | 51.4 | 52   | 126.0 | 85.0  | 12   | 175.7 | 118.6 | 72   | 225.5 | 148.7 | 132  | 277.0 | 187.5 |
| 33   | 27.4 | 18.5 | 93   | 77.1 | 52.0 | 53   | 126.8 | 85.6  | 13   | 176.6 | 119.1 | 73   | 226.3 | 149.2 | 133  | 277.9 | 188.1 |
| 34   | 28.2 | 19.0 | 94   | 77.9 | 52.6 | 54   | 127.7 | 86.1  | 14   | 177.4 | 119.7 | 74   | 227.1 | 149.7 | 134  | 278.8 | 188.7 |
| 35   | 29.0 | 19.6 | 95   | 78.8 | 53.1 | 55   | 128.5 | 86.7  | 15   | 178.2 | 120.2 | 75   | 228.0 | 150.2 | 135  | 279.7 | 189.3 |
| 36   | 29.8 | 20.1 | 96   | 79.6 | 53.7 | 56   | 129.3 | 87.2  | 16   | 179.1 | 120.8 | 76   | 228.8 | 150.7 | 136  | 280.6 | 189.9 |
| 37   | 30.7 | 20.7 | 97   | 80.4 | 54.2 | 57   | 130.2 | 87.8  | 17   | 179.9 | 121.3 | 77   | 229.6 | 151.2 | 137  | 281.5 | 190.5 |
| 38   | 31.5 | 21.2 | 98   | 81.2 | 54.8 | 58   | 131.0 | 88.4  | 18   | 180.7 | 121.9 | 78   | 230.5 | 151.7 | 138  | 282.4 | 191.1 |
| 39   | 32.3 | 21.8 | 99   | 82.1 | 55.4 | 59   | 131.8 | 88.9  | 19   | 181.6 | 122.5 | 79   | 231.3 | 152.2 | 139  | 283.3 | 191.7 |
| 40   | 33.2 | 22.4 | 100  | 82.0 | 55.9 | 60   | 132.6 | 89.5  | 20   | 182.4 | 123.0 | 80   | 232.1 | 152.7 | 140  | 284.2 | 192.3 |
| 41   | 34.0 | 22.8 | 101  | 83.8 | 56.5 | 161  | 133.5 | 90.0  | 221  | 183.2 | 123.6 | 281  | 232.9 | 153.2 | 141  | 285.1 | 192.9 |
| 42   | 34.8 | 23.5 | 02   | 84.6 | 57.0 | 62   | 134.3 | 90.6  | 22   | 184.0 | 124.1 | 82   | 233.8 | 153.7 | 142  | 286.0 | 193.5 |
| 43   | 35.6 | 24.0 | 03   | 85.4 | 57.6 | 63   | 135.1 | 91.1  | 23   | 184.9 | 124.7 | 83   | 234.6 | 154.2 | 143  | 286.9 | 194.1 |
| 44   | 36.5 | 24.6 | 04   | 86.2 | 58.2 | 64   | 136.0 | 91.7  | 24   | 185.7 | 125.3 | 84   | 235.4 | 154.7 | 144  | 287.8 | 194.7 |
| 45   | 37.3 | 25.2 | 05   | 87.0 | 58.7 | 65   | 136.8 | 92.3  | 25   | 186.5 | 125.8 | 85   | 236.3 | 155.2 | 145  | 288.7 | 195.3 |
| 46   | 38.1 | 25.7 | 06   | 87.9 | 59.3 | 66   | 137.6 | 92.8  | 26   | 187.4 | 126.4 | 86   | 237.1 | 155.7 | 146  | 289.6 | 195.9 |
| 47   | 39.0 | 26.3 | 07   | 88.7 | 59.8 | 67   | 138.4 | 93.4  | 27   | 188.2 | 126.9 | 87   | 237.9 | 156.2 | 147  | 290.5 | 196.5 |
| 48   | 39.8 | 26.8 | 08   | 89.5 | 60.4 | 68   | 139.3 | 93.9  | 28   | 189.0 | 127.5 | 88   | 238.8 | 156.7 | 148  | 291.4 | 197.1 |
| 49   | 40.6 | 27.4 | 09   | 90.4 | 61.0 | 69   | 140.1 | 94.5  | 29   | 189.8 | 128.1 | 89   | 239.6 | 157.2 | 149  | 292.3 | 197.7 |
| 50   | 41.5 | 28.0 | 10   | 91.2 | 61.5 | 70   | 140.9 | 95.1  | 30   | 190.7 | 128.6 | 90   | 240.4 | 157.7 | 150  | 293.2 | 198.3 |
| 51   | 42.3 | 28.5 | 111  | 92.0 | 62.1 | 171  | 141.8 | 95.6  | 231  | 191.5 | 129.2 | 291  | 241.2 | 158.2 | 151  | 294.1 | 198.9 |
| 52   | 43.1 | 29.1 | 12   | 92.8 | 62.6 | 72   | 142.6 | 96.2  | 32   | 192.3 | 129.7 | 92   | 242.1 | 158.7 | 152  | 295.0 | 199.5 |
| 53   | 43.9 | 29.6 | 13   | 93.7 | 63.2 | 73   | 143.4 | 96.7  | 33   | 193.2 | 130.3 | 93   | 242.9 | 159.2 | 153  | 295.9 | 200.1 |
| 54   | 44.8 | 30.2 | 14   | 94.5 | 63.7 | 74   | 144.2 | 97.3  | 34   | 194.0 | 130.9 | 94   | 243.7 | 159.7 | 154  | 296.8 | 200.7 |
| 55   | 45.6 | 30.8 | 15   | 95.3 | 64.3 | 75   | 145.1 | 97.9  | 35   | 194.8 | 131.4 | 95   | 244.6 | 160.2 | 155  | 297.7 | 201.3 |
| 56   | 46.4 | 31.3 | 16   | 96.2 | 64.9 | 76   | 145.9 | 98.4  | 36   | 195.6 | 132.0 | 96   | 245.4 | 160.7 | 156  | 298.6 | 201.9 |
| 57   | 47.3 | 31.9 | 17   | 97.0 | 65.4 | 77   | 146.7 | 99.0  | 37   | 196.5 | 132.5 | 97   | 246.3 | 161.2 | 157  | 299.5 | 202.5 |
| 58   | 48.1 | 32.4 | 18   | 97.8 | 66.0 | 78   | 147.6 | 99.5  | 38   | 197.3 | 133.1 | 98   | 247.2 | 161.7 | 158  | 300.4 | 203.1 |
| 59   | 48.9 | 33.0 | 19   | 98.7 | 66.5 | 79   | 148.4 | 100.1 | 39   | 198.1 | 133.6 | 99   | 248.1 | 162.2 | 159  | 301.3 | 203.7 |
| 60   | 49.7 | 33.6 | 20   | 99.5 | 67.1 | 180  | 149.2 | 100.7 | 240  | 199.0 | 134.2 | 300  | 249.0 | 162.7 | 160  | 302.2 | 204.3 |
| Dist | Dep  | Lat  | Dist | Dep  | Lat  | Dist | Dep   | Lat   | Dist | Dep   | Lat   | Dist | Dep   | Lat   | Dist | Dep   | Lat   |

for 56 Degrees.

TABLE III. Difference of Latitude and Departure for 35 Degrees.

| Dist | Lat. | Dep. | Dist | Lat. | Dep. | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  |
|------|------|------|------|------|------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.8 | 00.6 | 61   | 50.0 | 35.0 | 121  | 99.1  | 69.4  | 181  | 148.2 | 103.8 | 241  | 197.4 | 138.2 |
| 2    | 01.6 | 01.1 | 62   | 50.8 | 35.6 | 22   | 99.9  | 70.0  | 82   | 149.1 | 104.4 | 42   | 198.2 | 138.8 |
| 3    | 02.5 | 01.7 | 63   | 51.6 | 36.1 | 23   | 100.7 | 70.5  | 83   | 149.9 | 105.0 | 43   | 199.0 | 139.4 |
| 4    | 03.3 | 02.3 | 64   | 52.4 | 36.7 | 24   | 101.6 | 71.1  | 84   | 150.7 | 105.5 | 44   | 199.8 | 139.9 |
| 5    | 04.1 | 02.9 | 65   | 53.2 | 37.3 | 25   | 102.4 | 71.7  | 85   | 151.5 | 106.1 | 45   | 200.6 | 140.5 |
| 6    | 04.9 | 03.4 | 66   | 54.1 | 37.9 | 26   | 103.2 | 72.3  | 86   | 152.3 | 106.7 | 46   | 201.5 | 141.1 |
| 7    | 05.7 | 04.0 | 67   | 54.9 | 38.4 | 27   | 104.0 | 72.8  | 87   | 153.1 | 107.2 | 47   | 202.3 | 141.7 |
| 8    | 06.6 | 04.6 | 68   | 55.7 | 39.0 | 28   | 104.8 | 73.4  | 88   | 154.0 | 107.8 | 48   | 203.1 | 142.2 |
| 9    | 07.4 | 05.2 | 69   | 56.5 | 39.6 | 29   | 105.6 | 74.0  | 89   | 154.8 | 108.4 | 49   | 203.9 | 142.8 |
| 10   | 08.2 | 05.7 | 70   | 57.3 | 40.1 | 30   | 106.5 | 74.6  | 90   | 155.6 | 109.0 | 50   | 204.7 | 143.4 |
| 11   | 09.0 | 06.3 | 71   | 58.1 | 40.7 | 31   | 107.3 | 75.1  | 91   | 156.4 | 109.5 | 51   | 205.6 | 143.9 |
| 12   | 09.8 | 06.9 | 72   | 59.0 | 41.3 | 32   | 108.1 | 75.7  | 92   | 157.2 | 110.1 | 52   | 206.4 | 144.5 |
| 13   | 10.6 | 07.5 | 73   | 59.8 | 41.9 | 33   | 108.9 | 76.3  | 93   | 158.1 | 110.7 | 53   | 207.2 | 145.1 |
| 14   | 11.5 | 08.0 | 74   | 60.6 | 42.4 | 34   | 109.7 | 76.8  | 94   | 158.9 | 111.3 | 54   | 208.0 | 145.7 |
| 15   | 12.3 | 08.6 | 75   | 61.4 | 43.0 | 35   | 110.6 | 77.4  | 95   | 159.7 | 111.8 | 55   | 208.8 | 146.2 |
| 16   | 13.1 | 09.2 | 76   | 62.2 | 43.6 | 36   | 111.4 | 78.0  | 96   | 160.5 | 112.4 | 56   | 209.6 | 146.8 |
| 17   | 13.9 | 09.7 | 77   | 63.1 | 44.2 | 37   | 112.2 | 78.6  | 97   | 161.3 | 113.0 | 57   | 210.5 | 147.4 |
| 18   | 14.7 | 10.3 | 78   | 63.9 | 44.7 | 38   | 113.0 | 79.1  | 98   | 162.2 | 113.6 | 58   | 211.3 | 148.0 |
| 19   | 15.6 | 10.9 | 79   | 64.7 | 45.3 | 39   | 113.8 | 79.7  | 99   | 163.0 | 114.1 | 59   | 212.1 | 148.5 |
| 20   | 16.4 | 11.5 | 80   | 65.5 | 45.9 | 40   | 114.6 | 80.3  | 200  | 163.8 | 114.7 | 60   | 212.9 | 149.1 |
| 21   | 17.2 | 12.0 | 81   | 66.3 | 46.5 | 41   | 115.5 | 80.9  | 201  | 164.6 | 115.3 | 61   | 213.8 | 149.7 |
| 22   | 18.0 | 12.6 | 82   | 67.2 | 47.0 | 42   | 116.3 | 81.4  | 02   | 165.4 | 115.8 | 62   | 214.6 | 150.3 |
| 23   | 18.8 | 13.2 | 83   | 68.0 | 47.6 | 43   | 117.1 | 82.0  | 03   | 166.3 | 116.4 | 63   | 215.4 | 150.8 |
| 24   | 19.6 | 13.8 | 84   | 68.8 | 48.2 | 44   | 117.9 | 82.6  | 04   | 167.1 | 117.0 | 64   | 216.2 | 151.4 |
| 25   | 20.5 | 14.3 | 85   | 69.6 | 48.7 | 45   | 118.8 | 83.2  | 05   | 167.9 | 117.6 | 65   | 217.0 | 152.0 |
| 26   | 21.3 | 14.9 | 86   | 70.4 | 49.3 | 46   | 119.6 | 83.7  | 06   | 168.6 | 118.1 | 66   | 217.8 | 152.6 |
| 27   | 22.1 | 15.5 | 87   | 71.3 | 49.9 | 47   | 120.4 | 84.3  | 07   | 169.5 | 118.7 | 67   | 218.7 | 153.1 |
| 28   | 22.9 | 16.1 | 88   | 72.1 | 50.5 | 48   | 121.2 | 84.9  | 08   | 170.3 | 119.3 | 68   | 219.5 | 153.7 |
| 29   | 23.8 | 16.6 | 89   | 72.9 | 51.0 | 49   | 122.0 | 85.5  | 09   | 171.2 | 119.9 | 69   | 220.3 | 154.3 |
| 30   | 24.6 | 17.2 | 90   | 73.7 | 51.6 | 50   | 122.8 | 86.0  | 10   | 172.0 | 120.4 | 70   | 221.1 | 154.8 |
| 31   | 25.4 | 17.8 | 91   | 74.5 | 52.2 | 51   | 123.7 | 86.6  | 211  | 172.8 | 121.0 | 71   | 221.9 | 155.4 |
| 32   | 26.2 | 18.4 | 92   | 75.3 | 52.8 | 52   | 124.5 | 87.2  | 12   | 173.6 | 121.6 | 72   | 222.8 | 156.0 |
| 33   | 27.0 | 18.9 | 93   | 76.2 | 53.3 | 53   | 125.3 | 87.7  | 13   | 174.4 | 122.2 | 73   | 223.6 | 156.6 |
| 34   | 27.8 | 19.5 | 94   | 77.0 | 53.9 | 54   | 126.1 | 88.3  | 14   | 175.3 | 122.7 | 74   | 224.4 | 157.1 |
| 35   | 28.7 | 20.1 | 95   | 77.8 | 54.5 | 55   | 126.9 | 88.9  | 15   | 176.1 | 123.3 | 75   | 225.2 | 157.7 |
| 36   | 29.5 | 20.6 | 96   | 78.6 | 55.1 | 56   | 127.8 | 89.5  | 16   | 176.9 | 123.9 | 76   | 226.0 | 158.3 |
| 37   | 30.3 | 21.2 | 97   | 79.4 | 55.6 | 57   | 128.6 | 90.0  | 17   | 177.7 | 124.4 | 77   | 226.9 | 158.9 |
| 38   | 31.1 | 21.8 | 98   | 80.3 | 56.2 | 58   | 129.4 | 90.6  | 18   | 178.5 | 125.0 | 78   | 227.7 | 159.4 |
| 39   | 31.9 | 22.4 | 99   | 81.1 | 56.8 | 59   | 130.2 | 91.2  | 19   | 179.4 | 125.6 | 79   | 228.5 | 160.0 |
| 40   | 32.8 | 22.9 | 100  | 81.9 | 57.4 | 60   | 131.0 | 91.8  | 20   | 180.2 | 126.2 | 80   | 229.3 | 160.6 |
| 41   | 33.6 | 23.5 | 101  | 82.7 | 57.9 | 161  | 131.9 | 92.3  | 221  | 181.0 | 126.7 | 281  | 230.1 | 161.2 |
| 42   | 34.4 | 24.1 | 02   | 83.5 | 58.5 | 62   | 132.7 | 92.9  | 22   | 181.8 | 127.3 | 82   | 231.0 | 161.7 |
| 43   | 35.2 | 24.7 | 03   | 84.4 | 59.1 | 63   | 133.5 | 93.5  | 23   | 182.6 | 127.9 | 83   | 231.8 | 162.3 |
| 44   | 36.0 | 25.2 | 04   | 85.2 | 59.6 | 64   | 134.3 | 94.1  | 24   | 183.5 | 128.5 | 84   | 232.6 | 162.9 |
| 45   | 36.9 | 25.8 | 05   | 86.0 | 60.2 | 65   | 135.1 | 94.6  | 25   | 184.2 | 129.0 | 85   | 233.4 | 163.4 |
| 46   | 37.7 | 26.4 | 06   | 86.8 | 60.8 | 66   | 136.0 | 95.2  | 26   | 185.1 | 129.6 | 86   | 234.2 | 164.0 |
| 47   | 38.5 | 27.0 | 07   | 87.6 | 61.4 | 67   | 136.8 | 95.8  | 27   | 185.9 | 130.2 | 87   | 235.0 | 164.6 |
| 48   | 39.3 | 27.5 | 08   | 88.5 | 61.9 | 68   | 137.6 | 96.3  | 28   | 186.7 | 130.8 | 88   | 235.9 | 165.2 |
| 49   | 40.1 | 28.1 | 09   | 89.3 | 62.5 | 69   | 138.4 | 96.9  | 29   | 187.5 | 131.3 | 89   | 236.7 | 165.7 |
| 50   | 41.0 | 28.7 | 10   | 90.1 | 63.1 | 70   | 139.2 | 97.5  | 30   | 188.4 | 131.9 | 90   | 237.5 | 166.3 |
| 51   | 41.8 | 29.2 | 111  | 90.9 | 63.7 | 171  | 140.0 | 98.1  | 231  | 189.2 | 132.5 | 291  | 238.3 | 166.9 |
| 52   | 42.6 | 29.8 | 12   | 91.7 | 64.2 | 72   | 140.9 | 98.6  | 32   | 190.0 | 133.1 | 92   | 239.1 | 167.5 |
| 53   | 43.4 | 30.4 | 13   | 92.5 | 64.8 | 73   | 141.7 | 99.2  | 33   | 190.8 | 133.6 | 93   | 240.0 | 168.0 |
| 54   | 44.2 | 31.0 | 14   | 93.4 | 65.4 | 74   | 142.5 | 99.8  | 34   | 191.6 | 134.2 | 94   | 240.8 | 168.6 |
| 55   | 45.0 | 31.5 | 15   | 94.2 | 66.0 | 75   | 143.3 | 100.4 | 35   | 192.5 | 134.8 | 95   | 241.6 | 169.2 |
| 56   | 45.9 | 32.1 | 16   | 95.0 | 66.5 | 76   | 144.1 | 100.9 | 36   | 193.3 | 135.3 | 96   | 242.4 | 169.8 |
| 57   | 46.7 | 32.7 | 17   | 95.8 | 67.1 | 77   | 145.0 | 101.5 | 37   | 194.1 | 135.9 | 97   | 243.2 | 170.3 |
| 58   | 47.5 | 33.3 | 18   | 96.6 | 67.7 | 78   | 145.8 | 102.1 | 38   | 194.9 | 136.5 | 98   | 244.1 | 170.9 |
| 59   | 48.3 | 33.8 | 19   | 97.5 | 68.2 | 79   | 146.6 | 102.7 | 39   | 195.7 | 137.1 | 99   | 244.9 | 171.5 |
| 60   | 49.1 | 34.4 | 20   | 98.3 | 68.8 | 180  | 147.4 | 103.2 | 240  | 196.6 | 137.6 | 300  | 245.7 | 172.1 |

H h

for 55 Degrees.

TABLE III. Difference of Latitude and Departure for 36 Degrees.

| Dist | Lat. | Dep  | Dist | Lat. | Dep  | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep   | Dist | Lat.  | Dep   |
|------|------|------|------|------|------|------|-------|-------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.8 | 00.6 | 61   | 49.3 | 35.9 | 121  | 97.9  | 71.1  | 181  | 146.4 | 106.4 | 241  | 195.0 | 141.7 | 301  | 243.7 | 176.6 |
| 2    | 01.6 | 01.2 | 62   | 50.2 | 36.4 | 22   | 98.7  | 71.7  | 82   | 147.2 | 107.0 | 42   | 195.8 | 142.2 | 102  | 244.5 | 177.1 |
| 3    | 02.4 | 01.8 | 63   | 51.0 | 37.0 | 23   | 99.5  | 72.3  | 83   | 148.0 | 107.6 | 43   | 196.6 | 142.8 | 103  | 245.3 | 177.6 |
| 4    | 03.2 | 02.4 | 64   | 51.8 | 37.6 | 24   | 100.3 | 72.9  | 84   | 148.9 | 108.2 | 44   | 197.4 | 143.4 | 104  | 246.1 | 178.1 |
| 5    | 04.0 | 02.9 | 65   | 52.6 | 38.2 | 25   | 101.1 | 73.5  | 85   | 149.7 | 108.7 | 45   | 198.2 | 144.0 | 105  | 246.9 | 178.6 |
| 6    | 04.9 | 03.5 | 66   | 53.4 | 38.8 | 26   | 101.9 | 74.1  | 86   | 150.5 | 109.3 | 46   | 199.0 | 144.6 | 106  | 247.7 | 179.1 |
| 7    | 05.7 | 04.1 | 67   | 54.2 | 39.4 | 27   | 102.7 | 74.7  | 87   | 151.3 | 109.9 | 47   | 199.8 | 145.2 | 107  | 248.5 | 179.6 |
| 8    | 06.5 | 04.7 | 68   | 55.0 | 40.0 | 28   | 103.6 | 75.2  | 88   | 152.1 | 110.5 | 48   | 200.6 | 145.8 | 108  | 249.3 | 180.1 |
| 9    | 07.3 | 05.3 | 69   | 55.8 | 40.6 | 29   | 104.4 | 75.8  | 89   | 152.9 | 111.1 | 49   | 201.4 | 146.4 | 109  | 250.1 | 180.6 |
| 10   | 08.1 | 05.9 | 70   | 56.6 | 41.1 | 30   | 105.2 | 76.4  | 90   | 153.7 | 111.7 | 50   | 202.2 | 146.9 | 110  | 250.9 | 181.1 |
| 11   | 08.9 | 06.5 | 71   | 57.4 | 41.7 | 131  | 106.0 | 77.0  | 191  | 154.5 | 112.3 | 251  | 203.1 | 147.5 | 311  | 251.7 | 181.6 |
| 12   | 09.7 | 07.1 | 72   | 58.2 | 42.3 | 32   | 106.8 | 77.6  | 92   | 155.3 | 112.9 | 52   | 203.9 | 148.1 | 112  | 252.5 | 182.1 |
| 13   | 10.5 | 07.6 | 73   | 59.1 | 42.9 | 33   | 107.6 | 78.2  | 93   | 156.1 | 113.4 | 53   | 204.7 | 148.7 | 113  | 253.3 | 182.6 |
| 14   | 11.3 | 08.2 | 74   | 59.9 | 43.5 | 34   | 108.4 | 78.8  | 94   | 156.9 | 114.0 | 54   | 205.5 | 149.3 | 114  | 254.1 | 183.1 |
| 15   | 12.1 | 08.8 | 75   | 60.7 | 44.1 | 35   | 109.2 | 79.4  | 95   | 157.8 | 114.6 | 55   | 206.3 | 149.9 | 115  | 254.9 | 183.6 |
| 16   | 12.9 | 09.4 | 76   | 61.5 | 44.7 | 36   | 110.0 | 79.9  | 96   | 158.6 | 115.2 | 56   | 207.1 | 150.5 | 116  | 255.7 | 184.1 |
| 17   | 13.8 | 10.0 | 77   | 62.3 | 45.3 | 37   | 110.8 | 80.5  | 97   | 159.4 | 115.8 | 57   | 207.9 | 151.1 | 117  | 256.5 | 184.6 |
| 18   | 14.6 | 10.6 | 78   | 63.1 | 45.8 | 38   | 111.6 | 81.1  | 98   | 160.2 | 116.4 | 58   | 208.7 | 151.7 | 118  | 257.3 | 185.1 |
| 19   | 15.4 | 11.2 | 79   | 63.9 | 46.4 | 39   | 112.5 | 81.7  | 99   | 161.0 | 117.0 | 59   | 209.5 | 152.2 | 119  | 258.1 | 185.6 |
| 20   | 16.2 | 11.8 | 80   | 64.7 | 47.0 | 40   | 113.3 | 82.3  | 200  | 161.8 | 117.6 | 60   | 210.3 | 152.8 | 120  | 258.9 | 186.1 |
| 21   | 17.0 | 12.3 | 81   | 65.5 | 47.6 | 141  | 114.1 | 82.9  | 201  | 162.6 | 118.1 | 261  | 211.1 | 153.4 | 321  | 259.7 | 186.6 |
| 22   | 17.8 | 12.9 | 82   | 66.3 | 48.2 | 42   | 114.9 | 83.5  | 02   | 163.4 | 118.7 | 62   | 212.0 | 154.0 | 22   | 260.5 | 187.1 |
| 23   | 18.6 | 13.5 | 83   | 67.1 | 48.8 | 43   | 115.7 | 84.1  | 03   | 164.2 | 119.3 | 63   | 212.8 | 154.6 | 23   | 261.3 | 187.6 |
| 24   | 19.4 | 14.1 | 84   | 68.0 | 49.4 | 44   | 116.5 | 84.6  | 04   | 165.0 | 119.9 | 64   | 213.6 | 155.2 | 24   | 262.1 | 188.1 |
| 25   | 20.2 | 14.7 | 85   | 68.8 | 50.0 | 45   | 117.3 | 85.2  | 05   | 165.8 | 120.5 | 65   | 214.4 | 155.8 | 25   | 262.9 | 188.6 |
| 26   | 21.0 | 15.3 | 86   | 69.6 | 50.6 | 46   | 118.1 | 85.8  | 06   | 166.7 | 121.1 | 66   | 215.2 | 156.4 | 26   | 263.7 | 189.1 |
| 27   | 21.8 | 15.9 | 87   | 70.4 | 51.1 | 47   | 118.9 | 86.4  | 07   | 167.5 | 121.7 | 67   | 216.0 | 156.9 | 27   | 264.5 | 189.6 |
| 28   | 22.7 | 16.5 | 88   | 71.2 | 51.7 | 48   | 119.7 | 87.0  | 08   | 168.3 | 122.3 | 68   | 216.8 | 157.5 | 28   | 265.3 | 190.1 |
| 29   | 23.5 | 17.0 | 89   | 72.0 | 52.3 | 49   | 120.5 | 87.6  | 09   | 169.1 | 122.8 | 69   | 217.6 | 158.1 | 29   | 266.1 | 190.6 |
| 30   | 24.3 | 17.6 | 90   | 72.8 | 52.9 | 50   | 121.3 | 88.2  | 10   | 169.9 | 123.4 | 70   | 218.4 | 158.7 | 30   | 266.9 | 191.1 |
| 31   | 25.1 | 18.2 | 91   | 73.6 | 53.5 | 151  | 122.2 | 88.8  | 211  | 170.7 | 124.0 | 271  | 219.2 | 159.3 | 31   | 267.7 | 191.6 |
| 32   | 25.9 | 18.8 | 92   | 74.4 | 54.1 | 52   | 123.0 | 89.3  | 12   | 171.5 | 124.6 | 72   | 220.0 | 159.9 | 32   | 268.5 | 192.1 |
| 33   | 26.7 | 19.4 | 93   | 75.2 | 54.7 | 53   | 123.8 | 89.9  | 13   | 172.3 | 125.2 | 73   | 220.8 | 160.5 | 33   | 269.3 | 192.6 |
| 34   | 27.5 | 20.0 | 94   | 76.0 | 55.3 | 54   | 124.6 | 90.5  | 14   | 173.1 | 125.8 | 74   | 221.7 | 161.1 | 34   | 270.1 | 193.1 |
| 35   | 28.3 | 20.6 | 95   | 76.9 | 55.8 | 55   | 125.4 | 91.1  | 15   | 173.9 | 126.4 | 75   | 222.5 | 161.7 | 35   | 270.9 | 193.6 |
| 36   | 29.1 | 21.2 | 96   | 77.7 | 56.4 | 56   | 126.2 | 91.7  | 16   | 174.7 | 127.0 | 76   | 223.3 | 162.3 | 36   | 271.7 | 194.1 |
| 37   | 29.9 | 21.7 | 97   | 78.5 | 57.0 | 57   | 127.0 | 92.3  | 17   | 175.5 | 127.6 | 77   | 224.1 | 162.9 | 37   | 272.5 | 194.6 |
| 38   | 30.7 | 22.3 | 98   | 79.3 | 57.6 | 58   | 127.8 | 92.9  | 18   | 176.4 | 128.1 | 78   | 224.9 | 163.5 | 38   | 273.3 | 195.1 |
| 39   | 31.6 | 22.9 | 99   | 80.1 | 58.2 | 59   | 128.6 | 93.5  | 19   | 177.2 | 128.7 | 79   | 225.7 | 164.1 | 39   | 274.1 | 195.6 |
| 40   | 32.4 | 23.5 | 100  | 80.9 | 58.8 | 60   | 129.4 | 94.0  | 20   | 178.0 | 129.3 | 80   | 226.5 | 164.7 | 40   | 274.9 | 196.1 |
| 41   | 33.2 | 24.1 | 101  | 81.7 | 59.4 | 161  | 130.2 | 94.6  | 221  | 178.8 | 129.9 | 281  | 227.3 | 165.3 | 41   | 275.7 | 196.6 |
| 42   | 34.0 | 24.7 | 02   | 82.5 | 60.0 | 62   | 131.1 | 95.2  | 22   | 179.6 | 130.5 | 82   | 228.1 | 165.9 | 42   | 276.5 | 197.1 |
| 43   | 34.8 | 25.3 | 03   | 83.3 | 60.5 | 63   | 131.9 | 95.8  | 23   | 180.4 | 131.1 | 83   | 228.9 | 166.5 | 43   | 277.3 | 197.6 |
| 44   | 35.6 | 25.9 | 04   | 84.1 | 61.1 | 64   | 132.7 | 96.4  | 24   | 181.2 | 131.7 | 84   | 229.8 | 167.1 | 44   | 278.1 | 198.1 |
| 45   | 36.4 | 26.5 | 05   | 84.9 | 61.7 | 65   | 133.5 | 97.0  | 25   | 182.0 | 132.3 | 85   | 230.6 | 167.7 | 45   | 278.9 | 198.6 |
| 46   | 37.2 | 27.1 | 06   | 85.8 | 62.3 | 66   | 134.3 | 97.6  | 26   | 182.8 | 132.8 | 86   | 231.4 | 168.3 | 46   | 279.7 | 199.1 |
| 47   | 38.0 | 27.6 | 07   | 86.6 | 62.9 | 67   | 135.1 | 98.2  | 27   | 183.6 | 133.4 | 87   | 232.2 | 168.9 | 47   | 280.5 | 199.6 |
| 48   | 38.8 | 28.2 | 08   | 87.4 | 63.5 | 68   | 135.9 | 98.7  | 28   | 184.5 | 134.0 | 88   | 233.0 | 169.5 | 48   | 281.3 | 200.1 |
| 49   | 39.6 | 28.8 | 09   | 88.2 | 64.1 | 69   | 136.7 | 99.3  | 29   | 185.3 | 134.6 | 89   | 233.8 | 170.1 | 49   | 282.1 | 200.6 |
| 50   | 40.5 | 29.4 | 10   | 89.0 | 64.7 | 70   | 137.5 | 99.9  | 30   | 186.1 | 135.2 | 90   | 234.6 | 170.7 | 50   | 282.9 | 201.1 |
| 51   | 41.3 | 30.0 | 111  | 89.8 | 65.2 | 171  | 138.3 | 100.5 | 231  | 186.9 | 135.8 | 291  | 235.4 | 171.3 | 51   | 283.7 | 201.6 |
| 52   | 42.1 | 30.6 | 12   | 90.6 | 65.8 | 72   | 139.1 | 101.1 | 32   | 187.7 | 136.4 | 92   | 236.2 | 171.9 | 52   | 284.5 | 202.1 |
| 53   | 42.9 | 31.2 | 13   | 91.4 | 66.4 | 73   | 140.0 | 101.7 | 33   | 188.5 | 137.0 | 93   | 237.0 | 172.5 | 53   | 285.3 | 202.6 |
| 54   | 43.7 | 31.7 | 14   | 92.2 | 67.0 | 74   | 140.8 | 102.3 | 34   | 189.3 | 137.5 | 94   | 237.8 | 173.1 | 54   | 286.1 | 203.1 |
| 55   | 44.5 | 32.3 | 15   | 93.0 | 67.6 | 75   | 141.6 | 102.9 | 35   | 190.1 | 138.1 | 95   | 238.7 | 173.7 | 55   | 286.9 | 203.6 |
| 56   | 45.3 | 32.9 | 16   | 93.8 | 68.2 | 76   | 142.4 | 103.5 | 36   | 190.9 | 138.7 | 96   | 239.5 | 174.3 | 56   | 287.7 | 204.1 |
| 57   | 46.1 | 33.5 | 17   | 94.7 | 68.8 | 77   | 143.2 | 104.0 | 37   | 191.7 | 139.3 | 97   | 240.3 | 174.9 | 57   | 288.5 | 204.6 |
| 58   | 46.9 | 34.1 | 18   | 95.5 | 69.4 | 78   | 144.0 | 104.6 | 38   | 192.5 | 139.9 | 98   | 241.1 | 175.5 | 58   | 289.3 | 205.1 |
| 59   | 47.7 | 34.7 | 19   | 96.3 | 69.9 | 79   | 144.8 | 105.2 | 39   | 193.3 | 140.5 | 99   | 241.9 | 176.1 | 59   | 290.1 | 205.6 |
| 60   | 48.5 | 35.3 | 20   | 97.1 | 70.5 | 180  | 145.6 | 105.8 | 40   | 194.2 | 141.1 | 300  | 242.7 | 176.7 | 60   | 290.9 | 206.1 |
| Dist | Dep  | Lat. | Dist | Dep  | Lat. | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  |

for 54 Degrees.



TABLE III. Difference of Latitude and Departure for 37 Degrees.

| Diff | Lat  | Dep  | Diff | Lat  | Dep  | Diff | Lat   | Dep   | Diff | Lat   | Dep   | Diff | Lat   | Dep   | Diff | Lat | Dep |
|------|------|------|------|------|------|------|-------|-------|------|-------|-------|------|-------|-------|------|-----|-----|
| 1    | 00.8 | 00.6 | 61   | 48.7 | 36.7 | 121  | 96.6  | 72.8  | 181  | 144.5 | 108.9 | 241  | 192.5 | 145.0 |      |     |     |
| 2    | 01.6 | 01.2 | 62   | 49.5 | 37.3 | 22   | 97.4  | 73.4  | 82   | 145.3 | 109.5 | 42   | 193.3 | 145.6 |      |     |     |
| 3    | 02.4 | 01.8 | 63   | 50.3 | 37.9 | 23   | 98.2  | 74.0  | 83   | 146.1 | 110.1 | 43   | 194.1 | 146.2 |      |     |     |
| 4    | 03.2 | 02.4 | 64   | 51.1 | 38.5 | 24   | 99.0  | 74.6  | 84   | 146.9 | 110.7 | 44   | 194.9 | 146.8 |      |     |     |
| 5    | 04.0 | 03.0 | 65   | 51.9 | 39.1 | 25   | 99.8  | 75.2  | 85   | 147.7 | 111.3 | 45   | 195.7 | 147.4 |      |     |     |
| 6    | 04.8 | 03.6 | 66   | 52.7 | 39.7 | 26   | 100.6 | 75.8  | 86   | 148.5 | 111.9 | 46   | 196.5 | 148.0 |      |     |     |
| 7    | 05.6 | 04.2 | 67   | 53.5 | 40.3 | 27   | 101.4 | 76.4  | 87   | 149.3 | 112.5 | 47   | 197.3 | 148.6 |      |     |     |
| 8    | 06.4 | 04.8 | 68   | 54.3 | 40.9 | 28   | 102.2 | 77.0  | 88   | 150.1 | 113.1 | 48   | 198.1 | 149.2 |      |     |     |
| 9    | 07.2 | 05.4 | 69   | 55.1 | 41.5 | 29   | 103.0 | 77.6  | 89   | 150.9 | 113.7 | 49   | 198.9 | 149.8 |      |     |     |
| 10   | 08.0 | 06.0 | 70   | 55.9 | 42.1 | 30   | 103.8 | 78.2  | 90   | 151.7 | 114.3 | 50   | 199.7 | 150.4 |      |     |     |
| 11   | 08.8 | 06.6 | 71   | 56.7 | 42.7 | 131  | 104.6 | 78.8  | 91   | 152.5 | 114.9 | 251  | 200.4 | 151.0 |      |     |     |
| 12   | 09.6 | 07.2 | 72   | 57.5 | 43.3 | 32   | 105.4 | 79.4  | 92   | 153.3 | 115.5 | 52   | 201.2 | 151.6 |      |     |     |
| 13   | 10.4 | 07.8 | 73   | 58.3 | 43.9 | 33   | 106.2 | 80.0  | 93   | 154.1 | 116.1 | 53   | 202.0 | 152.2 |      |     |     |
| 14   | 11.2 | 08.4 | 74   | 59.1 | 44.5 | 34   | 107.0 | 80.6  | 94   | 154.9 | 116.7 | 54   | 202.8 | 152.9 |      |     |     |
| 15   | 12.0 | 09.0 | 75   | 59.9 | 45.1 | 35   | 107.8 | 81.2  | 95   | 155.7 | 117.3 | 55   | 203.6 | 153.5 |      |     |     |
| 16   | 12.8 | 09.6 | 76   | 60.7 | 45.7 | 36   | 108.6 | 81.8  | 96   | 156.5 | 117.9 | 56   | 204.4 | 154.1 |      |     |     |
| 17   | 13.6 | 10.2 | 77   | 61.5 | 46.3 | 37   | 109.4 | 82.4  | 97   | 157.3 | 118.6 | 57   | 205.2 | 154.7 |      |     |     |
| 18   | 14.4 | 10.8 | 78   | 62.3 | 46.9 | 38   | 110.2 | 83.0  | 98   | 158.1 | 119.2 | 58   | 206.0 | 155.3 |      |     |     |
| 19   | 15.2 | 11.4 | 79   | 63.1 | 47.5 | 39   | 111.0 | 83.6  | 99   | 158.9 | 119.8 | 59   | 206.8 | 155.9 |      |     |     |
| 20   | 16.0 | 12.0 | 80   | 63.9 | 48.1 | 40   | 111.8 | 84.2  | 200  | 159.7 | 120.4 | 60   | 207.6 | 156.5 |      |     |     |
| 21   | 16.8 | 12.6 | 81   | 64.7 | 48.7 | 141  | 112.6 | 84.9  | 201  | 160.5 | 121.0 | 261  | 208.4 | 157.1 |      |     |     |
| 22   | 17.6 | 13.2 | 82   | 65.5 | 49.3 | 42   | 113.4 | 85.5  | 02   | 161.3 | 121.6 | 62   | 209.2 | 157.7 |      |     |     |
| 23   | 18.4 | 13.8 | 83   | 66.3 | 49.9 | 43   | 114.2 | 86.1  | 03   | 162.1 | 122.2 | 63   | 210.0 | 158.3 |      |     |     |
| 24   | 19.2 | 14.4 | 84   | 67.1 | 50.6 | 44   | 115.0 | 86.7  | 04   | 162.9 | 122.8 | 64   | 210.8 | 158.9 |      |     |     |
| 25   | 20.0 | 15.0 | 85   | 67.9 | 51.2 | 45   | 115.8 | 87.3  | 05   | 163.7 | 123.4 | 65   | 211.6 | 159.5 |      |     |     |
| 26   | 20.8 | 15.6 | 86   | 68.7 | 51.8 | 46   | 116.6 | 87.9  | 06   | 164.5 | 124.0 | 66   | 212.4 | 160.1 |      |     |     |
| 27   | 21.6 | 16.2 | 87   | 69.5 | 52.4 | 47   | 117.4 | 88.5  | 07   | 165.3 | 124.6 | 67   | 213.2 | 160.7 |      |     |     |
| 28   | 22.4 | 16.9 | 88   | 70.3 | 53.0 | 48   | 118.2 | 89.1  | 08   | 166.1 | 125.2 | 68   | 214.0 | 161.3 |      |     |     |
| 29   | 23.2 | 17.5 | 89   | 71.1 | 53.6 | 49   | 119.0 | 89.7  | 09   | 166.9 | 125.8 | 69   | 214.8 | 161.9 |      |     |     |
| 30   | 24.0 | 18.1 | 90   | 71.9 | 54.2 | 50   | 119.8 | 90.3  | 10   | 167.7 | 126.4 | 70   | 215.6 | 162.5 |      |     |     |
| 31   | 24.8 | 18.7 | 91   | 72.7 | 54.8 | 151  | 120.6 | 90.9  | 211  | 168.5 | 127.0 | 271  | 216.4 | 163.1 |      |     |     |
| 32   | 25.6 | 19.3 | 92   | 73.5 | 55.4 | 52   | 121.4 | 91.5  | 12   | 169.3 | 127.6 | 72   | 217.2 | 163.7 |      |     |     |
| 33   | 26.4 | 19.9 | 93   | 74.3 | 56.0 | 53   | 122.2 | 92.1  | 13   | 170.1 | 128.2 | 73   | 218.0 | 164.3 |      |     |     |
| 34   | 27.2 | 20.5 | 94   | 75.1 | 56.6 | 54   | 123.0 | 92.7  | 14   | 170.9 | 128.8 | 74   | 218.8 | 164.9 |      |     |     |
| 35   | 28.0 | 21.1 | 95   | 75.9 | 57.2 | 55   | 123.8 | 93.3  | 15   | 171.7 | 129.4 | 75   | 219.6 | 165.5 |      |     |     |
| 36   | 28.8 | 21.7 | 96   | 76.7 | 57.8 | 56   | 124.6 | 93.9  | 16   | 172.5 | 130.0 | 76   | 220.4 | 166.1 |      |     |     |
| 37   | 29.5 | 22.3 | 97   | 77.5 | 58.4 | 57   | 125.4 | 94.5  | 17   | 173.3 | 130.6 | 77   | 221.2 | 166.7 |      |     |     |
| 38   | 30.3 | 22.9 | 98   | 78.3 | 59.0 | 58   | 126.2 | 95.1  | 18   | 174.1 | 131.2 | 78   | 222.0 | 167.3 |      |     |     |
| 39   | 31.1 | 23.5 | 99   | 79.1 | 59.6 | 59   | 127.0 | 95.7  | 19   | 174.9 | 131.8 | 79   | 222.8 | 167.9 |      |     |     |
| 40   | 31.9 | 24.1 | 100  | 79.9 | 60.2 | 60   | 127.8 | 96.3  | 20   | 175.7 | 132.4 | 80   | 223.6 | 168.5 |      |     |     |
| 41   | 32.7 | 24.7 | 101  | 80.7 | 60.8 | 161  | 128.6 | 96.9  | 221  | 176.5 | 133.0 | 281  | 224.4 | 169.1 |      |     |     |
| 42   | 33.5 | 25.3 | 02   | 81.5 | 61.4 | 62   | 129.4 | 97.5  | 22   | 177.3 | 133.6 | 82   | 225.2 | 169.7 |      |     |     |
| 43   | 34.3 | 25.9 | 03   | 82.3 | 62.0 | 63   | 130.2 | 98.1  | 23   | 178.1 | 134.2 | 83   | 226.0 | 170.3 |      |     |     |
| 44   | 35.1 | 26.5 | 04   | 83.1 | 62.6 | 64   | 131.0 | 98.7  | 24   | 178.9 | 134.8 | 84   | 226.8 | 170.9 |      |     |     |
| 45   | 35.9 | 27.1 | 05   | 83.9 | 63.2 | 65   | 131.8 | 99.3  | 25   | 179.7 | 135.4 | 85   | 227.6 | 171.5 |      |     |     |
| 46   | 36.7 | 27.7 | 06   | 84.7 | 63.8 | 66   | 132.6 | 99.9  | 26   | 180.5 | 136.0 | 86   | 228.4 | 172.1 |      |     |     |
| 47   | 37.5 | 28.3 | 07   | 85.5 | 64.4 | 67   | 133.4 | 100.5 | 27   | 181.3 | 136.6 | 87   | 229.2 | 172.7 |      |     |     |
| 48   | 38.3 | 28.9 | 08   | 86.3 | 65.0 | 68   | 134.2 | 101.1 | 28   | 182.1 | 137.2 | 88   | 230.0 | 173.3 |      |     |     |
| 49   | 39.1 | 29.5 | 09   | 87.1 | 65.6 | 69   | 135.0 | 101.7 | 29   | 182.9 | 137.8 | 89   | 230.8 | 173.9 |      |     |     |
| 50   | 39.9 | 30.1 | 10   | 87.9 | 66.2 | 70   | 135.8 | 102.3 | 30   | 183.7 | 138.4 | 90   | 231.6 | 174.5 |      |     |     |
| 51   | 40.7 | 30.7 | 111  | 88.6 | 66.8 | 171  | 136.6 | 102.9 | 231  | 184.5 | 139.0 | 291  | 232.4 | 175.1 |      |     |     |
| 52   | 41.5 | 31.3 | 12   | 89.4 | 67.4 | 72   | 137.4 | 103.5 | 32   | 185.3 | 139.6 | 92   | 233.2 | 175.7 |      |     |     |
| 53   | 42.3 | 31.9 | 13   | 90.2 | 68.0 | 73   | 138.2 | 104.1 | 33   | 186.1 | 140.2 | 93   | 234.0 | 176.3 |      |     |     |
| 54   | 43.1 | 32.5 | 14   | 91.0 | 68.6 | 74   | 139.0 | 104.7 | 34   | 186.9 | 140.8 | 94   | 234.8 | 176.9 |      |     |     |
| 55   | 43.9 | 33.1 | 15   | 91.8 | 69.2 | 75   | 139.8 | 105.3 | 35   | 187.7 | 141.4 | 95   | 235.6 | 177.5 |      |     |     |
| 56   | 44.7 | 33.7 | 16   | 92.6 | 69.8 | 76   | 140.6 | 105.9 | 36   | 188.5 | 142.0 | 96   | 236.4 | 178.1 |      |     |     |
| 57   | 45.5 | 34.3 | 17   | 93.4 | 70.4 | 77   | 141.4 | 106.5 | 37   | 189.3 | 142.6 | 97   | 237.2 | 178.7 |      |     |     |
| 58   | 46.3 | 34.9 | 18   | 94.2 | 71.0 | 78   | 142.2 | 107.1 | 38   | 190.1 | 143.2 | 98   | 238.0 | 179.3 |      |     |     |
| 59   | 47.1 | 35.5 | 19   | 95.0 | 71.6 | 79   | 142.9 | 107.7 | 39   | 190.9 | 143.8 | 99   | 238.8 | 179.9 |      |     |     |
| 60   | 47.9 | 36.1 | 120  | 95.8 | 72.2 | 180  | 143.7 | 108.3 | 240  | 191.7 | 144.4 | 300  | 239.6 | 180.5 |      |     |     |

H h 2

for 53 Degrees.

TABLE III. Difference of Latitude and Departure for 38 Degrees.

| Dist | Lat. | Dep. | Dist | Lat. | Dep. | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  |
|------|------|------|------|------|------|------|-------|-------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.8 | 00.6 | 61   | 48.1 | 37.6 | 121  | 95.3  | 74.3  | 181  | 142.6 | 111.4 | 241  | 189.9 | 144.4 | 301  | 237.2 | 189.9 |
| 2    | 01.6 | 01.2 | 62   | 48.9 | 38.2 | 22   | 96.1  | 75.1  | 82   | 143.4 | 112.1 | 42   | 190.7 | 145.0 | 102  | 238.0 | 190.7 |
| 3    | 02.4 | 01.8 | 63   | 49.6 | 38.8 | 23   | 96.9  | 75.7  | 83   | 144.2 | 112.7 | 43   | 191.5 | 145.6 | 103  | 238.8 | 191.5 |
| 4    | 03.2 | 02.5 | 64   | 50.4 | 39.4 | 24   | 97.7  | 76.3  | 84   | 145.0 | 113.3 | 44   | 192.3 | 146.2 | 104  | 239.6 | 192.3 |
| 5    | 03.9 | 03.1 | 65   | 51.2 | 40.0 | 25   | 98.5  | 77.0  | 85   | 145.8 | 113.9 | 45   | 193.1 | 146.8 | 105  | 240.4 | 193.1 |
| 6    | 04.7 | 03.7 | 66   | 52.0 | 40.6 | 26   | 99.3  | 77.6  | 86   | 146.5 | 114.5 | 46   | 193.8 | 147.4 | 106  | 241.2 | 193.8 |
| 7    | 05.5 | 04.3 | 67   | 52.8 | 41.3 | 27   | 100.1 | 78.2  | 87   | 147.3 | 115.1 | 47   | 194.6 | 148.0 | 107  | 242.0 | 194.6 |
| 8    | 06.3 | 04.9 | 68   | 53.6 | 41.9 | 28   | 100.9 | 78.8  | 88   | 148.1 | 115.8 | 48   | 195.4 | 148.6 | 108  | 242.8 | 195.4 |
| 9    | 07.1 | 05.5 | 69   | 54.4 | 42.5 | 29   | 101.6 | 79.4  | 89   | 148.9 | 116.4 | 49   | 196.2 | 149.2 | 109  | 243.6 | 196.2 |
| 10   | 07.9 | 06.2 | 70   | 55.2 | 43.1 | 30   | 102.4 | 80.0  | 90   | 149.7 | 117.0 | 50   | 197.0 | 149.8 | 110  | 244.4 | 197.0 |
| 11   | 08.7 | 06.8 | 71   | 55.9 | 43.7 | 31   | 103.2 | 80.7  | 191  | 150.5 | 117.6 | 251  | 197.8 | 150.4 | 311  | 245.2 | 197.8 |
| 12   | 09.5 | 07.4 | 72   | 56.7 | 44.3 | 32   | 104.0 | 81.3  | 92   | 151.3 | 118.2 | 52   | 198.6 | 151.0 | 312  | 246.0 | 198.6 |
| 13   | 10.2 | 08.0 | 73   | 57.5 | 44.9 | 33   | 104.8 | 81.9  | 93   | 152.1 | 118.8 | 53   | 199.4 | 151.6 | 313  | 246.8 | 199.4 |
| 14   | 11.0 | 08.6 | 74   | 58.3 | 45.6 | 34   | 105.6 | 82.5  | 94   | 152.9 | 119.4 | 54   | 200.2 | 152.2 | 314  | 247.6 | 200.2 |
| 15   | 11.8 | 09.2 | 75   | 59.1 | 46.2 | 35   | 106.4 | 83.1  | 95   | 153.6 | 120.1 | 55   | 201.0 | 152.8 | 315  | 248.4 | 201.0 |
| 16   | 12.6 | 09.9 | 76   | 59.9 | 46.8 | 36   | 107.1 | 83.7  | 96   | 154.4 | 120.7 | 56   | 201.8 | 153.4 | 316  | 249.2 | 201.8 |
| 17   | 13.4 | 10.5 | 77   | 60.7 | 47.4 | 37   | 107.9 | 84.4  | 97   | 155.2 | 121.3 | 57   | 202.6 | 154.0 | 317  | 250.0 | 202.6 |
| 18   | 14.2 | 11.1 | 78   | 61.5 | 48.0 | 38   | 108.7 | 85.0  | 98   | 156.0 | 121.9 | 58   | 203.4 | 154.6 | 318  | 250.8 | 203.4 |
| 19   | 15.0 | 11.7 | 79   | 62.2 | 48.6 | 39   | 109.5 | 85.6  | 99   | 156.8 | 122.5 | 59   | 204.2 | 155.2 | 319  | 251.6 | 204.2 |
| 20   | 15.8 | 12.3 | 80   | 63.0 | 49.3 | 40   | 110.3 | 86.2  | 200  | 157.6 | 123.1 | 60   | 205.0 | 155.8 | 320  | 252.4 | 205.0 |
| 21   | 16.5 | 12.9 | 81   | 63.8 | 49.9 | 141  | 111.1 | 86.8  | 201  | 158.4 | 123.8 | 261  | 205.8 | 156.4 | 321  | 253.2 | 205.8 |
| 22   | 17.3 | 13.5 | 82   | 64.6 | 50.5 | 42   | 111.9 | 87.4  | 02   | 159.2 | 124.4 | 62   | 206.6 | 157.0 | 322  | 254.0 | 206.6 |
| 23   | 18.1 | 14.2 | 83   | 65.4 | 51.1 | 43   | 112.7 | 88.0  | 03   | 159.9 | 125.0 | 63   | 207.4 | 157.6 | 323  | 254.8 | 207.4 |
| 24   | 18.9 | 14.8 | 84   | 66.2 | 51.7 | 44   | 113.5 | 88.7  | 04   | 160.7 | 125.6 | 64   | 208.2 | 158.2 | 324  | 255.6 | 208.2 |
| 25   | 19.7 | 15.4 | 85   | 67.0 | 52.3 | 45   | 114.2 | 89.3  | 05   | 161.5 | 126.2 | 65   | 209.0 | 158.8 | 325  | 256.4 | 209.0 |
| 26   | 20.5 | 16.0 | 86   | 67.8 | 53.0 | 46   | 115.0 | 89.9  | 06   | 162.3 | 126.8 | 66   | 209.8 | 159.4 | 326  | 257.2 | 209.8 |
| 27   | 21.3 | 16.6 | 87   | 68.5 | 53.6 | 47   | 115.8 | 90.5  | 07   | 163.1 | 127.4 | 67   | 210.6 | 160.0 | 327  | 258.0 | 210.6 |
| 28   | 22.1 | 17.2 | 88   | 69.3 | 54.2 | 48   | 116.6 | 91.1  | 08   | 163.9 | 128.1 | 68   | 211.4 | 160.6 | 328  | 258.8 | 211.4 |
| 29   | 22.9 | 17.9 | 89   | 70.1 | 54.8 | 49   | 117.4 | 91.7  | 09   | 164.7 | 128.7 | 69   | 212.2 | 161.2 | 329  | 259.6 | 212.2 |
| 30   | 23.6 | 18.5 | 90   | 70.9 | 55.4 | 50   | 118.2 | 92.4  | 10   | 165.5 | 129.3 | 70   | 213.0 | 161.8 | 330  | 260.4 | 213.0 |
| 31   | 24.4 | 19.1 | 91   | 71.7 | 56.0 | 151  | 119.7 | 93.0  | 21   | 166.2 | 129.9 | 271  | 213.8 | 162.4 | 331  | 261.2 | 213.8 |
| 32   | 25.2 | 19.7 | 92   | 72.5 | 56.6 | 52   | 119.8 | 93.6  | 12   | 167.0 | 130.5 | 72   | 214.6 | 163.0 | 332  | 262.0 | 214.6 |
| 33   | 26.0 | 20.3 | 93   | 73.3 | 57.3 | 53   | 120.5 | 94.2  | 13   | 167.8 | 131.1 | 73   | 215.4 | 163.6 | 333  | 262.8 | 215.4 |
| 34   | 26.8 | 20.9 | 94   | 74.1 | 57.9 | 54   | 121.3 | 94.8  | 14   | 168.6 | 131.8 | 74   | 216.2 | 164.2 | 334  | 263.6 | 216.2 |
| 35   | 27.6 | 21.5 | 95   | 74.9 | 58.5 | 55   | 122.1 | 95.4  | 15   | 169.4 | 132.4 | 75   | 217.0 | 164.8 | 335  | 264.4 | 217.0 |
| 36   | 28.4 | 22.2 | 96   | 75.6 | 59.1 | 56   | 122.9 | 96.0  | 16   | 170.2 | 133.0 | 76   | 217.8 | 165.4 | 336  | 265.2 | 217.8 |
| 37   | 29.2 | 22.8 | 97   | 76.4 | 59.7 | 57   | 123.7 | 96.7  | 17   | 171.0 | 133.6 | 77   | 218.6 | 166.0 | 337  | 266.0 | 218.6 |
| 38   | 29.9 | 23.4 | 98   | 77.2 | 60.3 | 58   | 124.5 | 97.3  | 18   | 171.8 | 134.2 | 78   | 219.4 | 166.6 | 338  | 266.8 | 219.4 |
| 39   | 30.7 | 24.0 | 99   | 78.0 | 61.0 | 59   | 125.3 | 97.9  | 19   | 172.5 | 134.8 | 79   | 220.2 | 167.2 | 339  | 267.6 | 220.2 |
| 40   | 31.5 | 24.6 | 100  | 78.8 | 61.6 | 60   | 126.1 | 98.5  | 20   | 173.3 | 135.5 | 80   | 221.0 | 167.8 | 340  | 268.4 | 221.0 |
| 41   | 32.3 | 25.2 | 101  | 79.6 | 62.2 | 161  | 126.9 | 99.1  | 221  | 174.1 | 136.1 | 281  | 221.8 | 168.4 | 341  | 269.2 | 221.8 |
| 42   | 33.1 | 25.9 | 02   | 80.4 | 62.8 | 62   | 127.6 | 99.7  | 22   | 174.9 | 136.7 | 82   | 222.6 | 169.0 | 342  | 270.0 | 222.6 |
| 43   | 33.9 | 26.5 | 03   | 81.2 | 63.4 | 63   | 128.4 | 100.4 | 23   | 175.7 | 137.3 | 83   | 223.4 | 169.6 | 343  | 270.8 | 223.4 |
| 44   | 34.7 | 27.1 | 04   | 81.9 | 64.0 | 64   | 129.2 | 101.0 | 24   | 176.5 | 137.9 | 84   | 224.2 | 170.2 | 344  | 271.6 | 224.2 |
| 45   | 35.5 | 27.7 | 05   | 82.7 | 64.6 | 65   | 130.0 | 101.6 | 25   | 177.3 | 138.5 | 85   | 225.0 | 170.8 | 345  | 272.4 | 225.0 |
| 46   | 36.2 | 28.3 | 06   | 83.5 | 65.3 | 66   | 130.8 | 102.2 | 26   | 178.1 | 139.1 | 86   | 225.8 | 171.4 | 346  | 273.2 | 225.8 |
| 47   | 37.0 | 28.9 | 07   | 84.3 | 65.9 | 67   | 131.6 | 102.8 | 27   | 178.9 | 139.8 | 87   | 226.6 | 172.0 | 347  | 274.0 | 226.6 |
| 48   | 37.8 | 29.6 | 08   | 85.1 | 66.5 | 68   | 132.4 | 103.4 | 28   | 179.6 | 140.4 | 88   | 227.4 | 172.6 | 348  | 274.8 | 227.4 |
| 49   | 38.6 | 30.2 | 09   | 85.9 | 67.1 | 69   | 133.2 | 104.1 | 29   | 180.4 | 141.0 | 89   | 228.2 | 173.2 | 349  | 275.6 | 228.2 |
| 50   | 39.4 | 30.8 | 10   | 86.7 | 67.7 | 70   | 133.9 | 104.7 | 30   | 181.2 | 141.6 | 90   | 229.0 | 173.8 | 350  | 276.4 | 229.0 |
| 51   | 40.2 | 31.4 | 11   | 87.5 | 68.3 | 171  | 134.7 | 105.3 | 231  | 182.0 | 142.2 | 291  | 229.8 | 174.4 | 351  | 277.2 | 229.8 |
| 52   | 41.0 | 32.0 | 12   | 88.2 | 69.0 | 72   | 135.5 | 105.9 | 32   | 182.8 | 142.8 | 92   | 230.6 | 175.0 | 352  | 278.0 | 230.6 |
| 53   | 41.8 | 32.6 | 13   | 89.0 | 69.6 | 73   | 136.3 | 106.5 | 33   | 183.6 | 143.5 | 93   | 231.4 | 175.6 | 353  | 278.8 | 231.4 |
| 54   | 42.5 | 33.2 | 14   | 89.8 | 70.2 | 74   | 137.1 | 107.1 | 34   | 184.4 | 144.1 | 94   | 232.2 | 176.2 | 354  | 279.6 | 232.2 |
| 55   | 43.3 | 33.9 | 15   | 90.6 | 70.8 | 75   | 137.9 | 107.7 | 35   | 185.2 | 144.7 | 95   | 233.0 | 176.8 | 355  | 280.4 | 233.0 |
| 56   | 44.1 | 34.5 | 16   | 91.4 | 71.4 | 76   | 138.7 | 108.4 | 36   | 185.9 | 145.3 | 96   | 233.8 | 177.4 | 356  | 281.2 | 233.8 |
| 57   | 44.9 | 35.1 | 17   | 92.2 | 72.0 | 77   | 139.5 | 109.0 | 37   | 186.7 | 145.9 | 97   | 234.6 | 178.0 | 357  | 282.0 | 234.6 |
| 58   | 45.7 | 35.7 | 18   | 93.0 | 72.7 | 78   | 140.2 | 109.6 | 38   | 187.5 | 146.5 | 98   | 235.4 | 178.6 | 358  | 282.8 | 235.4 |
| 59   | 46.5 | 36.3 | 19   | 93.8 | 73.3 | 79   | 141.0 | 110.2 | 39   | 188.3 | 147.2 | 99   | 236.2 | 179.2 | 359  | 283.6 | 236.2 |
| 60   | 47.3 | 36.9 | 20   | 94.5 | 73.9 | 180  | 141.8 | 110.8 | 240  | 189.1 | 147.8 | 300  | 237.0 | 179.8 | 360  | 284.4 | 237.0 |
| Dist | Dep. | Lat. | Dist | Dep. | Lat. | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  |

for 52 Degrees.





TABLE III. Difference of Latitude and Departure for 40 Degrees.

| Dist | Lat. | Dep  | Dist | Lat. | Dep  | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  |
|------|------|------|------|------|------|------|-------|-------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.8 | 00.6 | 61   | 46.7 | 39.2 | 121  | 92.7  | 77.8  | 181  | 138.6 | 116.4 | 241  | 184.6 | 154.9 | 301  | 230.6 | 184.9 |
| 2    | 01.5 | 01.3 | 62   | 47.5 | 39.9 | 22   | 93.4  | 78.4  | 82   | 139.4 | 117.0 | 42   | 185.4 | 155.6 | 102  | 231.4 | 185.6 |
| 3    | 02.3 | 01.9 | 63   | 48.3 | 40.5 | 23   | 94.2  | 79.1  | 83   | 140.2 | 117.7 | 43   | 186.1 | 156.2 | 103  | 232.1 | 186.2 |
| 4    | 03.1 | 02.6 | 64   | 49.0 | 41.1 | 24   | 95.0  | 79.7  | 84   | 140.9 | 118.3 | 44   | 186.9 | 156.9 | 104  | 232.8 | 186.9 |
| 5    | 03.8 | 03.2 | 65   | 49.8 | 41.8 | 25   | 95.7  | 80.4  | 85   | 141.7 | 118.9 | 45   | 187.7 | 157.5 | 105  | 233.5 | 187.5 |
| 6    | 04.6 | 03.9 | 66   | 50.6 | 42.4 | 26   | 96.5  | 81.0  | 86   | 142.5 | 119.6 | 46   | 188.4 | 158.1 | 106  | 234.2 | 188.1 |
| 7    | 05.4 | 04.5 | 67   | 51.3 | 43.1 | 27   | 97.3  | 81.6  | 87   | 143.2 | 120.2 | 47   | 189.2 | 158.8 | 107  | 234.9 | 188.8 |
| 8    | 06.1 | 05.1 | 68   | 52.1 | 43.7 | 28   | 98.0  | 82.3  | 88   | 144.0 | 120.9 | 48   | 190.0 | 159.4 | 108  | 235.6 | 189.4 |
| 9    | 06.9 | 05.8 | 69   | 52.9 | 44.4 | 29   | 98.8  | 82.9  | 89   | 144.8 | 121.5 | 49   | 190.7 | 160.1 | 109  | 236.3 | 190.1 |
| 10   | 07.7 | 05.4 | 70   | 53.6 | 45.0 | 30   | 99.6  | 83.6  | 90   | 145.5 | 122.1 | 50   | 191.5 | 160.7 | 110  | 237.0 | 190.7 |
| 11   | 08.4 | 07.1 | 71   | 54.4 | 45.6 | 31   | 100.3 | 84.2  | 91   | 146.3 | 122.8 | 51   | 192.3 | 161.4 | 111  | 237.7 | 191.4 |
| 12   | 09.2 | 07.7 | 72   | 55.2 | 46.3 | 32   | 101.1 | 84.9  | 92   | 147.1 | 123.4 | 52   | 193.0 | 162.0 | 112  | 238.4 | 192.0 |
| 13   | 10.0 | 08.4 | 73   | 55.9 | 46.9 | 33   | 101.9 | 85.5  | 93   | 147.8 | 124.1 | 53   | 193.8 | 162.6 | 113  | 239.1 | 192.6 |
| 14   | 10.7 | 09.0 | 74   | 56.7 | 47.6 | 34   | 102.6 | 86.1  | 94   | 148.6 | 124.7 | 54   | 194.6 | 163.3 | 114  | 239.8 | 193.3 |
| 15   | 11.5 | 09.6 | 75   | 57.4 | 48.2 | 35   | 103.4 | 86.8  | 95   | 149.4 | 125.4 | 55   | 195.3 | 163.9 | 115  | 240.5 | 193.9 |
| 16   | 12.3 | 10.3 | 76   | 58.2 | 48.9 | 36   | 104.2 | 87.4  | 96   | 150.1 | 126.0 | 56   | 196.1 | 164.6 | 116  | 241.2 | 194.6 |
| 17   | 13.0 | 10.9 | 77   | 59.0 | 49.5 | 37   | 104.9 | 88.1  | 97   | 150.9 | 126.6 | 57   | 196.9 | 165.2 | 117  | 241.9 | 195.2 |
| 18   | 13.8 | 11.6 | 78   | 59.7 | 50.1 | 38   | 105.7 | 88.7  | 98   | 151.7 | 127.3 | 58   | 197.6 | 165.8 | 118  | 242.6 | 195.8 |
| 19   | 14.6 | 12.2 | 79   | 60.5 | 50.8 | 39   | 106.5 | 89.4  | 99   | 152.4 | 127.9 | 59   | 198.4 | 166.5 | 119  | 243.3 | 196.5 |
| 20   | 15.3 | 12.9 | 80   | 61.3 | 51.4 | 40   | 107.2 | 90.0  | 200  | 153.2 | 128.6 | 60   | 199.2 | 167.1 | 120  | 244.0 | 197.1 |
| 21   | 16.1 | 13.5 | 81   | 62.0 | 52.1 | 41   | 108.0 | 90.6  | 201  | 154.0 | 129.2 | 261  | 199.9 | 167.8 | 121  | 244.7 | 197.8 |
| 22   | 16.9 | 14.1 | 82   | 62.8 | 52.7 | 42   | 108.8 | 91.3  | 02   | 154.7 | 129.9 | 62   | 200.7 | 168.4 | 122  | 245.4 | 198.4 |
| 23   | 17.6 | 14.8 | 83   | 63.6 | 53.4 | 43   | 109.5 | 91.9  | 03   | 155.5 | 130.5 | 63   | 201.4 | 169.1 | 123  | 246.1 | 199.1 |
| 24   | 18.4 | 15.4 | 84   | 64.3 | 54.0 | 44   | 110.3 | 92.6  | 04   | 156.3 | 131.1 | 64   | 202.2 | 169.7 | 124  | 246.8 | 199.7 |
| 25   | 19.2 | 16.1 | 85   | 65.1 | 54.6 | 45   | 111.1 | 93.2  | 05   | 157.0 | 131.8 | 65   | 203.0 | 170.4 | 125  | 247.5 | 200.4 |
| 26   | 19.9 | 16.7 | 86   | 65.9 | 55.3 | 46   | 111.8 | 93.9  | 06   | 157.8 | 132.4 | 66   | 203.7 | 171.0 | 126  | 248.2 | 201.0 |
| 27   | 20.7 | 17.4 | 87   | 66.6 | 55.9 | 47   | 112.6 | 94.5  | 07   | 158.6 | 133.1 | 67   | 204.5 | 171.6 | 127  | 248.9 | 201.6 |
| 28   | 21.4 | 18.0 | 88   | 67.4 | 56.6 | 48   | 113.4 | 95.1  | 08   | 159.3 | 133.7 | 68   | 205.3 | 172.3 | 128  | 249.6 | 202.3 |
| 29   | 22.2 | 18.6 | 89   | 68.2 | 57.2 | 49   | 114.1 | 95.8  | 09   | 160.1 | 134.4 | 69   | 206.0 | 172.9 | 129  | 250.3 | 202.9 |
| 30   | 23.0 | 19.3 | 90   | 68.9 | 57.9 | 50   | 114.9 | 96.4  | 10   | 160.9 | 135.0 | 70   | 206.8 | 173.6 | 130  | 251.0 | 203.6 |
| 31   | 23.7 | 19.9 | 91   | 69.7 | 58.5 | 51   | 115.7 | 97.1  | 211  | 161.6 | 135.6 | 271  | 207.6 | 174.2 | 131  | 251.7 | 204.2 |
| 32   | 24.5 | 20.6 | 92   | 70.5 | 59.1 | 52   | 116.4 | 97.7  | 12   | 162.4 | 136.3 | 72   | 208.3 | 174.8 | 132  | 252.4 | 204.8 |
| 33   | 25.3 | 21.2 | 93   | 71.2 | 59.8 | 53   | 117.2 | 98.4  | 13   | 163.2 | 136.9 | 73   | 209.1 | 175.5 | 133  | 253.1 | 205.5 |
| 34   | 26.0 | 21.9 | 94   | 72.0 | 60.4 | 54   | 118.0 | 99.0  | 14   | 163.9 | 137.6 | 74   | 209.9 | 176.1 | 134  | 253.8 | 206.1 |
| 35   | 26.8 | 22.5 | 95   | 72.8 | 61.1 | 55   | 118.7 | 99.6  | 15   | 164.7 | 138.2 | 75   | 210.6 | 176.8 | 135  | 254.5 | 206.8 |
| 36   | 27.6 | 23.1 | 96   | 73.5 | 61.7 | 56   | 119.5 | 100.3 | 16   | 165.4 | 138.8 | 76   | 211.4 | 177.4 | 136  | 255.2 | 207.4 |
| 37   | 28.3 | 23.8 | 97   | 74.3 | 62.4 | 57   | 120.3 | 100.9 | 17   | 166.2 | 139.5 | 77   | 212.2 | 178.1 | 137  | 255.9 | 208.1 |
| 38   | 29.1 | 24.4 | 98   | 75.1 | 63.0 | 58   | 121.0 | 101.6 | 18   | 167.0 | 140.1 | 78   | 212.9 | 178.7 | 138  | 256.6 | 208.7 |
| 39   | 29.9 | 25.1 | 99   | 75.8 | 63.6 | 59   | 121.8 | 102.2 | 19   | 167.7 | 140.8 | 79   | 213.7 | 179.3 | 139  | 257.3 | 209.4 |
| 40   | 30.6 | 25.7 | 100  | 76.6 | 64.3 | 60   | 122.6 | 102.8 | 20   | 168.5 | 141.4 | 80   | 214.5 | 180.0 | 140  | 258.0 | 210.0 |
| 41   | 31.4 | 26.4 | 101  | 77.4 | 64.9 | 161  | 123.3 | 103.5 | 221  | 169.3 | 142.1 | 281  | 215.2 | 180.6 | 141  | 258.7 | 210.6 |
| 42   | 32.2 | 27.0 | 02   | 78.1 | 65.6 | 62   | 124.1 | 104.1 | 22   | 170.0 | 142.7 | 82   | 216.0 | 181.3 | 142  | 259.4 | 211.3 |
| 43   | 32.9 | 27.6 | 03   | 78.9 | 66.2 | 63   | 124.9 | 104.8 | 23   | 170.8 | 143.3 | 83   | 216.8 | 181.9 | 143  | 260.1 | 211.9 |
| 44   | 33.7 | 28.3 | 04   | 79.7 | 66.8 | 64   | 125.6 | 105.4 | 24   | 171.6 | 144.0 | 84   | 217.5 | 182.6 | 144  | 260.8 | 212.6 |
| 45   | 34.5 | 28.9 | 05   | 80.4 | 67.5 | 65   | 126.4 | 106.1 | 25   | 172.3 | 144.6 | 85   | 218.3 | 183.2 | 145  | 261.5 | 213.2 |
| 46   | 35.2 | 29.6 | 06   | 81.2 | 68.1 | 66   | 127.2 | 106.7 | 26   | 173.1 | 145.3 | 86   | 219.1 | 183.9 | 146  | 262.2 | 213.9 |
| 47   | 36.0 | 30.2 | 07   | 82.0 | 68.8 | 67   | 127.9 | 107.3 | 27   | 173.9 | 145.9 | 87   | 219.8 | 184.5 | 147  | 262.9 | 214.5 |
| 48   | 36.8 | 30.8 | 08   | 82.7 | 69.4 | 68   | 128.7 | 108.0 | 28   | 174.6 | 146.6 | 88   | 220.6 | 185.1 | 148  | 263.6 | 215.1 |
| 49   | 37.5 | 31.5 | 09   | 83.5 | 70.1 | 69   | 129.4 | 108.6 | 29   | 175.4 | 147.2 | 89   | 221.4 | 185.8 | 149  | 264.3 | 215.8 |
| 50   | 38.3 | 32.1 | 10   | 84.3 | 70.7 | 70   | 130.2 | 109.3 | 30   | 176.2 | 147.9 | 90   | 222.1 | 186.4 | 150  | 265.0 | 216.4 |
| 51   | 39.1 | 32.8 | 111  | 85.0 | 71.3 | 171  | 131.0 | 109.9 | 231  | 176.9 | 148.3 | 291  | 222.9 | 187.1 | 151  | 265.7 | 217.1 |
| 52   | 39.8 | 33.4 | 12   | 85.8 | 72.0 | 72   | 131.7 | 110.6 | 32   | 177.7 | 149.1 | 92   | 223.7 | 187.7 | 152  | 266.4 | 217.7 |
| 53   | 40.6 | 34.1 | 13   | 86.6 | 72.6 | 73   | 132.5 | 111.2 | 33   | 178.5 | 149.8 | 93   | 224.4 | 188.4 | 153  | 267.1 | 218.4 |
| 54   | 41.4 | 34.7 | 14   | 87.3 | 73.3 | 74   | 133.3 | 111.9 | 34   | 179.2 | 150.4 | 94   | 225.2 | 189.0 | 154  | 267.8 | 219.0 |
| 55   | 42.1 | 35.3 | 15   | 88.1 | 73.9 | 75   | 134.0 | 112.5 | 35   | 180.0 | 151.1 | 95   | 226.0 | 189.6 | 155  | 268.5 | 219.6 |
| 56   | 42.9 | 36.0 | 16   | 88.9 | 74.6 | 76   | 134.8 | 113.1 | 36   | 180.8 | 151.7 | 96   | 226.7 | 190.3 | 156  | 269.2 | 220.3 |
| 57   | 43.7 | 36.6 | 17   | 89.6 | 75.2 | 77   | 135.6 | 113.8 | 37   | 181.5 | 152.4 | 97   | 227.5 | 190.9 | 157  | 269.9 | 220.9 |
| 58   | 44.4 | 37.3 | 18   | 90.4 | 75.9 | 78   | 136.3 | 114.4 | 38   | 182.3 | 153.0 | 98   | 228.3 | 191.6 | 158  | 270.6 | 221.6 |
| 59   | 45.2 | 37.9 | 19   | 91.2 | 76.5 | 79   | 137.1 | 115.1 | 39   | 183.1 | 153.6 | 99   | 229.0 | 192.2 | 159  | 271.3 | 222.2 |
| 60   | 46.0 | 38.6 | 120  | 91.9 | 77.1 | 180  | 137.9 | 115.7 | 240  | 183.8 | 154.3 | 300  | 229.8 | 192.9 | 160  | 272.0 | 222.9 |
| Dist | Dep  | Lat  | Dist | Dep  | Lat  | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  |

for 50 Degrees.

TABLE III. Difference of Latitude and Departure for 41 Degrees.

| Diff. | Lat. | Dep. | Diff. | Lat. | Dep. | Diff. | Lat.  | Dep.  | Diff. | Lat.  | Dep.  | Diff. | Lat.  | Dep.  |
|-------|------|------|-------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1     | 00.8 | 00.7 | 61    | 46.0 | 40.0 | 121   | 91.3  | 79.4  | 181   | 136.6 | 118.7 | 241   | 181.9 | 158.4 |
| 2     | 01.5 | 01.3 | 62    | 46.8 | 40.7 | 22    | 92.1  | 80.0  | 82    | 137.4 | 119.4 | 42    | 182.6 | 158.7 |
| 3     | 02.3 | 02.0 | 63    | 47.5 | 41.3 | 23    | 92.8  | 80.7  | 83    | 138.1 | 120.0 | 43    | 183.4 | 159.4 |
| 4     | 03.0 | 02.6 | 64    | 48.3 | 42.0 | 24    | 93.6  | 81.3  | 84    | 138.9 | 120.7 | 44    | 184.2 | 160.0 |
| 5     | 03.8 | 03.3 | 65    | 49.1 | 42.6 | 25    | 94.3  | 82.0  | 85    | 139.6 | 121.4 | 45    | 184.9 | 160.7 |
| 6     | 04.5 | 03.9 | 66    | 49.8 | 43.3 | 26    | 95.1  | 82.6  | 86    | 140.4 | 122.0 | 46    | 185.7 | 161.4 |
| 7     | 05.3 | 04.6 | 67    | 50.6 | 44.0 | 27    | 95.8  | 83.3  | 87    | 141.1 | 122.7 | 47    | 186.4 | 162.0 |
| 8     | 06.0 | 05.2 | 68    | 51.3 | 44.6 | 28    | 96.6  | 84.0  | 88    | 141.9 | 123.3 | 48    | 187.2 | 162.7 |
| 9     | 06.8 | 05.9 | 69    | 52.1 | 45.3 | 29    | 97.4  | 84.6  | 89    | 142.6 | 124.0 | 49    | 187.9 | 163.3 |
| 10    | 07.5 | 06.6 | 70    | 52.8 | 45.9 | 30    | 98.1  | 85.3  | 90    | 143.4 | 124.6 | 50    | 188.7 | 164.0 |
| 11    | 08.3 | 07.2 | 71    | 53.6 | 46.6 | 31    | 98.9  | 85.9  | 91    | 144.2 | 125.3 | 51    | 189.4 | 164.6 |
| 12    | 09.1 | 07.9 | 72    | 54.3 | 47.2 | 32    | 99.6  | 86.6  | 92    | 144.9 | 125.9 | 52    | 190.2 | 165.3 |
| 13    | 09.8 | 08.5 | 73    | 55.1 | 47.9 | 33    | 100.4 | 87.2  | 93    | 145.7 | 126.6 | 53    | 190.9 | 166.0 |
| 14    | 10.6 | 09.2 | 74    | 55.8 | 48.5 | 34    | 101.1 | 87.9  | 94    | 146.4 | 127.3 | 54    | 191.7 | 166.6 |
| 15    | 11.3 | 09.8 | 75    | 56.6 | 49.2 | 35    | 101.9 | 88.6  | 95    | 147.2 | 127.9 | 55    | 192.5 | 167.3 |
| 16    | 12.1 | 10.5 | 76    | 57.4 | 49.9 | 36    | 102.6 | 89.2  | 96    | 147.9 | 128.6 | 56    | 193.2 | 167.9 |
| 17    | 12.8 | 11.2 | 77    | 58.1 | 50.5 | 37    | 103.4 | 89.9  | 97    | 148.7 | 129.2 | 57    | 194.0 | 168.6 |
| 18    | 13.6 | 11.8 | 78    | 58.9 | 51.2 | 38    | 104.2 | 90.5  | 98    | 149.4 | 129.9 | 58    | 194.7 | 169.2 |
| 19    | 14.3 | 12.5 | 79    | 59.6 | 51.8 | 39    | 104.9 | 91.2  | 99    | 150.2 | 130.5 | 59    | 195.5 | 169.9 |
| 20    | 15.1 | 13.1 | 80    | 60.4 | 52.5 | 40    | 105.7 | 91.8  | 200   | 150.9 | 131.2 | 60    | 196.2 | 170.5 |
| 21    | 15.8 | 13.8 | 81    | 61.1 | 53.1 | 41    | 106.4 | 92.5  | 201   | 151.7 | 131.8 | 61    | 197.0 | 171.2 |
| 22    | 16.6 | 14.4 | 82    | 61.9 | 53.8 | 42    | 107.2 | 93.1  | 02    | 152.5 | 132.5 | 62    | 197.7 | 171.9 |
| 23    | 17.4 | 15.1 | 83    | 62.6 | 54.4 | 43    | 107.9 | 93.8  | 03    | 153.2 | 133.2 | 63    | 198.5 | 172.5 |
| 24    | 18.1 | 15.7 | 84    | 63.4 | 55.1 | 44    | 108.7 | 94.5  | 04    | 154.0 | 133.8 | 64    | 199.2 | 173.2 |
| 25    | 18.9 | 16.4 | 85    | 64.2 | 55.8 | 45    | 109.4 | 95.1  | 05    | 154.7 | 134.5 | 65    | 200.0 | 173.8 |
| 26    | 19.6 | 17.1 | 86    | 64.9 | 56.4 | 46    | 110.2 | 95.8  | 06    | 155.5 | 135.1 | 66    | 200.8 | 174.5 |
| 27    | 20.4 | 17.7 | 87    | 65.7 | 57.1 | 47    | 110.9 | 96.4  | 07    | 156.2 | 135.8 | 67    | 201.5 | 175.1 |
| 28    | 21.1 | 18.4 | 88    | 66.4 | 57.7 | 48    | 111.7 | 97.1  | 08    | 157.0 | 136.4 | 68    | 202.3 | 175.8 |
| 29    | 21.9 | 19.0 | 89    | 67.2 | 58.4 | 49    | 112.5 | 97.7  | 09    | 157.7 | 137.1 | 69    | 203.0 | 176.4 |
| 30    | 22.6 | 19.7 | 90    | 67.9 | 59.0 | 50    | 113.2 | 98.4  | 10    | 158.5 | 137.7 | 70    | 203.8 | 177.1 |
| 31    | 23.4 | 20.3 | 91    | 68.7 | 59.7 | 51    | 114.0 | 99.0  | 211   | 159.2 | 138.4 | 271   | 204.5 | 177.8 |
| 32    | 24.2 | 21.0 | 92    | 69.4 | 60.4 | 52    | 114.7 | 99.7  | 12    | 160.0 | 139.1 | 72    | 205.3 | 178.4 |
| 33    | 24.9 | 21.6 | 93    | 70.2 | 61.0 | 53    | 115.5 | 100.4 | 13    | 160.8 | 139.7 | 73    | 206.0 | 179.1 |
| 34    | 25.7 | 22.3 | 94    | 70.9 | 61.7 | 54    | 116.2 | 101.0 | 14    | 161.5 | 140.4 | 74    | 206.8 | 179.7 |
| 35    | 26.4 | 23.0 | 95    | 71.7 | 62.3 | 55    | 117.0 | 101.7 | 15    | 162.3 | 141.0 | 75    | 207.5 | 180.4 |
| 36    | 27.2 | 23.6 | 96    | 72.5 | 63.0 | 56    | 117.7 | 102.3 | 16    | 163.0 | 141.7 | 76    | 208.3 | 181.0 |
| 37    | 27.9 | 24.3 | 97    | 73.2 | 63.6 | 57    | 118.5 | 103.0 | 17    | 163.7 | 142.3 | 77    | 209.1 | 181.7 |
| 38    | 28.7 | 24.9 | 98    | 74.0 | 64.3 | 58    | 119.2 | 103.6 | 18    | 164.5 | 143.0 | 78    | 209.8 | 182.4 |
| 39    | 29.4 | 25.6 | 99    | 74.7 | 64.9 | 59    | 120.0 | 104.3 | 19    | 165.3 | 143.6 | 79    | 210.6 | 183.0 |
| 40    | 30.2 | 26.2 | 100   | 75.5 | 65.6 | 60    | 120.8 | 105.0 | 20    | 166.0 | 144.3 | 80    | 211.3 | 183.7 |
| 41    | 30.9 | 26.9 | 101   | 76.2 | 66.3 | 61    | 121.5 | 105.6 | 221   | 166.8 | 145.0 | 281   | 212.1 | 184.3 |
| 42    | 31.7 | 27.6 | 02    | 77.0 | 66.9 | 62    | 122.3 | 106.3 | 22    | 167.5 | 145.6 | 82    | 212.8 | 185.0 |
| 43    | 32.5 | 28.2 | 03    | 77.7 | 67.6 | 63    | 123.0 | 106.9 | 23    | 168.3 | 146.3 | 83    | 213.6 | 185.6 |
| 44    | 33.2 | 28.9 | 04    | 78.5 | 68.2 | 64    | 123.8 | 107.6 | 24    | 169.1 | 146.9 | 84    | 214.3 | 186.3 |
| 45    | 34.0 | 29.5 | 05    | 79.2 | 68.9 | 65    | 124.5 | 108.2 | 25    | 169.8 | 147.6 | 85    | 215.1 | 186.9 |
| 46    | 34.7 | 30.2 | 06    | 80.0 | 69.5 | 66    | 125.3 | 108.9 | 26    | 170.6 | 148.2 | 86    | 215.8 | 187.6 |
| 47    | 35.5 | 30.8 | 07    | 80.8 | 70.2 | 67    | 126.0 | 109.5 | 27    | 171.3 | 148.9 | 87    | 216.6 | 188.3 |
| 48    | 36.2 | 31.5 | 08    | 81.5 | 70.8 | 68    | 126.8 | 110.2 | 28    | 172.1 | 149.6 | 88    | 217.4 | 188.9 |
| 49    | 37.0 | 32.1 | 09    | 82.3 | 71.5 | 69    | 127.5 | 110.9 | 29    | 172.8 | 150.2 | 89    | 218.1 | 189.6 |
| 50    | 37.7 | 32.8 | 10    | 83.0 | 72.2 | 70    | 128.3 | 111.5 | 30    | 173.6 | 150.9 | 90    | 218.9 | 190.3 |
| 51    | 38.5 | 33.5 | 111   | 83.8 | 72.8 | 171   | 129.1 | 112.2 | 231   | 174.3 | 151.5 | 291   | 219.6 | 190.9 |
| 52    | 39.2 | 34.1 | 12    | 84.5 | 73.5 | 72    | 129.8 | 112.8 | 32    | 175.1 | 152.2 | 92    | 220.4 | 191.5 |
| 53    | 40.0 | 34.8 | 13    | 85.3 | 74.1 | 73    | 130.6 | 113.5 | 33    | 175.8 | 152.8 | 93    | 221.1 | 192.2 |
| 54    | 40.8 | 35.4 | 14    | 86.0 | 74.8 | 74    | 131.3 | 114.1 | 34    | 176.6 | 153.5 | 94    | 221.9 | 192.8 |
| 55    | 41.5 | 36.1 | 15    | 86.8 | 75.4 | 75    | 132.1 | 114.8 | 35    | 177.4 | 154.1 | 95    | 222.6 | 193.5 |
| 56    | 42.3 | 36.7 | 16    | 87.5 | 76.1 | 76    | 132.8 | 115.4 | 36    | 178.1 | 154.8 | 96    | 223.4 | 194.2 |
| 57    | 43.0 | 37.4 | 17    | 88.3 | 76.7 | 77    | 133.6 | 116.1 | 37    | 178.9 | 155.5 | 97    | 224.2 | 194.8 |
| 58    | 43.8 | 38.0 | 18    | 89.1 | 77.4 | 78    | 134.3 | 116.8 | 38    | 179.6 | 156.1 | 98    | 224.9 | 195.5 |
| 59    | 44.5 | 38.7 | 19    | 89.8 | 78.1 | 79    | 135.1 | 117.4 | 39    | 180.4 | 156.8 | 99    | 225.7 | 196.1 |
| 60    | 45.3 | 39.4 | 120   | 90.6 | 78.7 | 180   | 135.8 | 118.1 | 240   | 181.1 | 157.4 | 300   | 226.4 | 196.8 |

for 49 Degrees.

TABLE III. Difference of Latitude and Departure for 42 Degrees.

| Dist | Lat. | Dep  | Dist | Lat. | Dep  | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  |
|------|------|------|------|------|------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.7 | 00.7 | 61   | 45.3 | 40.8 | 121  | 89.9  | 80.9  | 181  | 134.5 | 121.1 | 241  | 179.0 | 101.1 |
| 2    | 01.5 | 01.3 | 62   | 46.8 | 41.5 | 22   | 90.6  | 81.6  | 82   | 135.2 | 121.8 | 42   | 179.3 | 101.1 |
| 3    | 02.2 | 02.0 | 63   | 46.8 | 42.1 | 23   | 91.4  | 82.3  | 83   | 135.9 | 122.4 | 43   | 180.5 | 102.2 |
| 4    | 03.0 | 02.7 | 64   | 47.5 | 42.8 | 24   | 92.1  | 83.0  | 84   | 136.7 | 123.1 | 44   | 181.3 | 103.3 |
| 5    | 03.7 | 03.3 | 65   | 48.3 | 43.5 | 25   | 92.9  | 83.6  | 85   | 137.4 | 123.8 | 45   | 182.0 | 103.3 |
| 6    | 04.5 | 04.0 | 66   | 49.0 | 44.2 | 26   | 93.6  | 84.3  | 86   | 138.2 | 124.4 | 46   | 182.7 | 104.4 |
| 7    | 05.2 | 04.7 | 67   | 49.8 | 44.8 | 27   | 94.3  | 85.0  | 87   | 138.9 | 125.1 | 47   | 183.5 | 105.5 |
| 8    | 05.9 | 05.4 | 68   | 50.5 | 45.5 | 28   | 95.1  | 85.6  | 88   | 139.7 | 125.8 | 48   | 184.2 | 105.5 |
| 9    | 06.7 | 06.0 | 69   | 51.3 | 46.2 | 29   | 95.8  | 86.3  | 89   | 140.4 | 126.4 | 49   | 185.0 | 106.6 |
| 10   | 07.4 | 06.7 | 70   | 52.0 | 46.8 | 30   | 96.6  | 87.0  | 90   | 141.1 | 127.1 | 50   | 185.7 | 107.7 |
| 11   | 08.2 | 07.4 | 71   | 52.7 | 47.5 | 31   | 97.3  | 87.6  | 91   | 141.9 | 127.8 | 51   | 186.5 | 107.7 |
| 12   | 08.9 | 08.0 | 72   | 53.5 | 48.2 | 32   | 98.1  | 88.3  | 92   | 142.6 | 128.4 | 52   | 187.2 | 108.8 |
| 13   | 09.7 | 08.7 | 73   | 54.2 | 48.8 | 33   | 98.8  | 89.0  | 93   | 143.4 | 129.1 | 53   | 187.9 | 109.9 |
| 14   | 10.4 | 09.4 | 74   | 55.0 | 49.5 | 34   | 99.5  | 89.6  | 94   | 144.1 | 129.8 | 54   | 188.7 | 109.9 |
| 15   | 11.1 | 10.0 | 75   | 55.7 | 50.2 | 35   | 100.3 | 90.3  | 95   | 144.9 | 130.5 | 55   | 189.4 | 110.0 |
| 16   | 11.9 | 10.7 | 76   | 56.5 | 50.8 | 36   | 101.0 | 91.0  | 96   | 145.6 | 131.1 | 56   | 190.2 | 111.1 |
| 17   | 12.6 | 11.4 | 77   | 57.2 | 51.5 | 37   | 101.8 | 91.7  | 97   | 146.3 | 131.8 | 57   | 190.9 | 111.1 |
| 18   | 13.4 | 12.0 | 78   | 57.9 | 52.2 | 38   | 102.5 | 92.3  | 98   | 147.1 | 132.5 | 58   | 191.7 | 112.2 |
| 19   | 14.1 | 12.7 | 79   | 58.7 | 52.9 | 39   | 103.3 | 93.0  | 99   | 147.8 | 133.1 | 59   | 192.4 | 113.3 |
| 20   | 14.9 | 13.4 | 80   | 59.4 | 53.5 | 40   | 104.0 | 93.7  | 200  | 148.6 | 133.8 | 60   | 193.1 | 113.3 |
| 21   | 15.6 | 14.0 | 81   | 60.2 | 54.2 | 41   | 104.7 | 94.3  | 201  | 149.3 | 134.5 | 61   | 193.9 | 114.4 |
| 22   | 16.3 | 14.7 | 82   | 60.9 | 54.9 | 42   | 105.5 | 95.0  | 02   | 150.1 | 135.1 | 62   | 194.6 | 115.5 |
| 23   | 17.1 | 15.4 | 83   | 61.7 | 55.5 | 43   | 106.2 | 95.7  | 03   | 150.8 | 135.8 | 63   | 195.4 | 115.5 |
| 24   | 17.8 | 16.1 | 84   | 62.4 | 56.2 | 44   | 107.0 | 96.3  | 04   | 151.5 | 136.5 | 64   | 196.1 | 116.6 |
| 25   | 18.6 | 16.7 | 85   | 63.1 | 56.9 | 45   | 107.7 | 97.0  | 05   | 152.3 | 137.1 | 65   | 196.9 | 117.7 |
| 26   | 19.3 | 17.4 | 86   | 63.9 | 57.5 | 46   | 108.5 | 97.7  | 06   | 153.0 | 137.8 | 66   | 197.6 | 117.7 |
| 27   | 20.1 | 18.1 | 87   | 64.6 | 58.2 | 47   | 109.2 | 98.3  | 07   | 153.8 | 138.5 | 67   | 198.3 | 118.8 |
| 28   | 20.8 | 18.7 | 88   | 65.4 | 58.9 | 48   | 109.9 | 99.0  | 08   | 154.5 | 139.1 | 68   | 199.1 | 119.9 |
| 29   | 21.5 | 19.4 | 89   | 66.1 | 59.5 | 49   | 110.7 | 99.7  | 09   | 155.3 | 139.8 | 69   | 199.8 | 120.0 |
| 30   | 22.3 | 20.1 | 90   | 66.9 | 60.2 | 50   | 111.4 | 100.4 | 10   | 156.0 | 140.5 | 70   | 200.6 | 120.0 |
| 31   | 23.0 | 20.7 | 91   | 67.6 | 60.9 | 51   | 112.2 | 101.0 | 211  | 156.7 | 141.2 | 71   | 201.3 | 121.1 |
| 32   | 23.8 | 21.4 | 92   | 68.3 | 61.5 | 52   | 112.9 | 101.7 | 12   | 157.5 | 141.8 | 72   | 202.1 | 122.2 |
| 33   | 24.5 | 22.1 | 93   | 69.1 | 62.2 | 53   | 113.7 | 102.4 | 13   | 158.2 | 142.5 | 73   | 202.8 | 122.2 |
| 34   | 25.3 | 22.7 | 94   | 69.8 | 62.9 | 54   | 114.4 | 103.0 | 14   | 159.0 | 143.2 | 74   | 203.5 | 123.3 |
| 35   | 26.0 | 23.4 | 95   | 70.6 | 63.6 | 55   | 115.1 | 103.7 | 15   | 159.7 | 143.8 | 75   | 204.3 | 124.4 |
| 36   | 26.7 | 24.1 | 96   | 71.3 | 64.2 | 56   | 115.9 | 104.4 | 16   | 160.5 | 144.5 | 76   | 205.0 | 124.4 |
| 37   | 27.5 | 24.8 | 97   | 72.1 | 64.9 | 57   | 116.6 | 105.0 | 17   | 161.2 | 145.2 | 77   | 205.8 | 125.5 |
| 38   | 28.2 | 25.4 | 98   | 72.8 | 65.6 | 58   | 117.4 | 105.7 | 18   | 161.9 | 145.8 | 78   | 206.5 | 125.5 |
| 39   | 29.0 | 26.1 | 99   | 73.5 | 66.2 | 59   | 118.1 | 106.4 | 19   | 162.7 | 146.5 | 79   | 207.3 | 126.6 |
| 40   | 29.7 | 26.8 | 100  | 74.3 | 66.9 | 60   | 118.9 | 107.0 | 20   | 163.4 | 147.2 | 80   | 208.0 | 126.6 |
| 41   | 30.5 | 27.4 | 101  | 75.0 | 67.6 | 61   | 119.6 | 107.7 | 221  | 164.2 | 147.8 | 281  | 208.7 | 127.7 |
| 42   | 31.2 | 28.1 | 02   | 75.8 | 68.2 | 62   | 120.3 | 108.4 | 22   | 164.9 | 148.5 | 82   | 209.5 | 128.8 |
| 43   | 31.9 | 28.8 | 03   | 76.5 | 68.9 | 63   | 121.1 | 109.0 | 23   | 165.7 | 149.2 | 83   | 210.2 | 128.8 |
| 44   | 32.7 | 29.4 | 04   | 77.3 | 69.6 | 64   | 121.8 | 109.7 | 24   | 166.4 | 149.9 | 84   | 211.0 | 129.9 |
| 45   | 33.4 | 30.1 | 05   | 78.0 | 70.2 | 65   | 122.6 | 110.4 | 25   | 167.1 | 150.5 | 85   | 211.7 | 129.9 |
| 46   | 34.2 | 30.8 | 06   | 78.7 | 70.9 | 66   | 123.3 | 111.0 | 26   | 167.9 | 151.2 | 86   | 212.5 | 131.0 |
| 47   | 34.9 | 31.4 | 07   | 79.5 | 71.6 | 67   | 124.1 | 111.7 | 27   | 168.6 | 151.9 | 87   | 213.2 | 131.0 |
| 48   | 35.7 | 32.1 | 08   | 80.2 | 72.3 | 68   | 124.8 | 112.4 | 28   | 169.4 | 152.5 | 88   | 213.9 | 132.1 |
| 49   | 36.4 | 32.8 | 09   | 81.0 | 72.9 | 69   | 125.5 | 113.1 | 29   | 170.1 | 153.2 | 89   | 214.7 | 133.2 |
| 50   | 37.1 | 33.5 | 10   | 81.7 | 73.6 | 70   | 126.3 | 113.7 | 30   | 170.9 | 153.9 | 90   | 215.4 | 133.2 |
| 51   | 37.9 | 34.1 | 111  | 82.5 | 74.3 | 171  | 127.0 | 114.4 | 231  | 171.6 | 154.5 | 291  | 216.2 | 134.3 |
| 52   | 38.6 | 34.8 | 12   | 83.2 | 74.9 | 72   | 127.8 | 115.1 | 32   | 172.3 | 155.2 | 92   | 216.9 | 135.4 |
| 53   | 39.4 | 35.5 | 13   | 83.9 | 75.6 | 73   | 128.5 | 115.7 | 33   | 173.1 | 155.9 | 93   | 217.7 | 136.5 |
| 54   | 40.1 | 36.1 | 14   | 84.7 | 76.3 | 74   | 129.3 | 116.4 | 34   | 173.8 | 156.5 | 94   | 218.4 | 136.5 |
| 55   | 40.9 | 36.8 | 15   | 85.4 | 76.9 | 75   | 130.0 | 117.1 | 35   | 174.6 | 157.2 | 95   | 219.1 | 137.6 |
| 56   | 41.6 | 37.5 | 16   | 86.2 | 77.6 | 76   | 130.7 | 117.7 | 36   | 175.3 | 157.9 | 96   | 219.9 | 138.7 |
| 57   | 42.3 | 38.1 | 17   | 86.9 | 78.3 | 77   | 131.5 | 118.4 | 37   | 176.1 | 158.5 | 97   | 220.6 | 138.7 |
| 58   | 43.1 | 38.8 | 18   | 87.7 | 78.9 | 78   | 132.2 | 119.1 | 38   | 176.8 | 159.2 | 98   | 221.4 | 139.8 |
| 59   | 43.8 | 39.5 | 19   | 88.4 | 79.6 | 79   | 133.0 | 119.7 | 39   | 177.5 | 159.9 | 99   | 222.1 | 140.9 |
| 60   | 44.6 | 40.1 | 20   | 89.1 | 80.2 | 180  | 133.7 | 120.4 | 240  | 178.3 | 160.6 | 300  | 222.9 | 141.0 |
| Dist | Dep  | Lat. | Dist | Dep  | Lat. | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  |

for 48 Degrees.



TABLE III. Difference of Latitude and Departure for 43 Degrees.

| Dist | Lat. | Dep  | Dist | Lat  | Dep  | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  | Dist | Lat.  | Dep.  |
|------|------|------|------|------|------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.7 | 00.7 | 61   | 44.6 | 41.6 | 121  | 88.5  | 82.5  | 181  | 132.4 | 123.4 | 241  | 176.3 | 164.3 |
| 2    | 01.5 | 01.4 | 62   | 45.3 | 42.3 | 22   | 89.2  | 83.2  | 82   | 133.1 | 124.1 | 42   | 177.0 | 165.0 |
| 3    | 02.2 | 02.0 | 63   | 46.1 | 43.0 | 23   | 90.0  | 83.9  | 83   | 133.8 | 124.8 | 43   | 177.7 | 165.7 |
| 4    | 02.9 | 02.7 | 64   | 46.8 | 43.6 | 24   | 90.7  | 84.6  | 84   | 134.6 | 125.5 | 44   | 178.4 | 166.4 |
| 5    | 03.7 | 03.4 | 65   | 47.5 | 44.3 | 25   | 91.4  | 85.2  | 85   | 135.3 | 126.2 | 45   | 179.2 | 167.1 |
| 6    | 04.4 | 04.1 | 66   | 48.3 | 45.0 | 26   | 92.1  | 85.9  | 86   | 136.0 | 126.8 | 46   | 179.9 | 167.7 |
| 7    | 05.1 | 04.8 | 67   | 49.0 | 45.7 | 27   | 92.9  | 86.6  | 87   | 136.8 | 127.5 | 47   | 180.6 | 168.4 |
| 8    | 05.9 | 05.5 | 68   | 49.7 | 46.4 | 28   | 93.6  | 87.3  | 88   | 137.5 | 128.2 | 48   | 181.4 | 169.1 |
| 9    | 06.6 | 06.2 | 69   | 50.5 | 47.1 | 29   | 94.3  | 88.0  | 89   | 138.2 | 128.9 | 49   | 182.1 | 169.8 |
| 10   | 07.3 | 06.8 | 70   | 51.2 | 47.7 | 30   | 95.1  | 88.6  | 90   | 139.0 | 129.5 | 50   | 182.8 | 170.5 |
| 11   | 08.0 | 07.5 | 71   | 51.9 | 48.4 | 31   | 95.8  | 89.3  | 91   | 139.7 | 130.2 | 51   | 183.6 | 171.2 |
| 12   | 08.8 | 08.2 | 72   | 52.7 | 49.1 | 32   | 96.5  | 90.0  | 92   | 140.4 | 130.9 | 52   | 184.3 | 171.8 |
| 13   | 09.5 | 08.9 | 73   | 53.4 | 49.8 | 33   | 97.3  | 90.7  | 93   | 141.1 | 131.6 | 53   | 185.0 | 172.5 |
| 14   | 10.2 | 09.5 | 74   | 54.1 | 50.5 | 34   | 98.0  | 91.4  | 94   | 141.9 | 132.3 | 54   | 185.8 | 173.2 |
| 15   | 11.0 | 10.2 | 75   | 54.9 | 51.2 | 35   | 98.7  | 92.1  | 95   | 142.6 | 133.0 | 55   | 186.5 | 173.9 |
| 16   | 11.7 | 10.9 | 76   | 55.6 | 51.8 | 36   | 99.5  | 92.7  | 96   | 143.3 | 133.6 | 56   | 187.2 | 174.5 |
| 17   | 12.4 | 11.6 | 77   | 56.3 | 52.5 | 37   | 100.2 | 93.4  | 97   | 144.1 | 134.3 | 57   | 187.9 | 175.2 |
| 18   | 13.2 | 12.3 | 78   | 57.0 | 53.2 | 38   | 100.9 | 94.1  | 98   | 144.8 | 135.0 | 58   | 188.7 | 175.9 |
| 19   | 13.9 | 13.0 | 79   | 57.8 | 53.9 | 39   | 101.7 | 94.8  | 99   | 145.5 | 135.7 | 59   | 189.4 | 176.6 |
| 20   | 14.6 | 13.6 | 80   | 58.5 | 54.5 | 40   | 102.4 | 95.5  | 200  | 146.3 | 136.4 | 60   | 190.1 | 177.3 |
| 21   | 15.4 | 14.3 | 81   | 59.2 | 55.2 | 41   | 103.1 | 96.2  | 201  | 147.0 | 137.1 | 61   | 190.9 | 178.0 |
| 22   | 16.1 | 15.0 | 82   | 60.0 | 55.9 | 42   | 103.9 | 96.8  | 02   | 147.7 | 137.7 | 62   | 191.6 | 178.6 |
| 23   | 16.8 | 15.7 | 83   | 60.7 | 56.6 | 43   | 104.6 | 97.5  | 03   | 148.5 | 138.4 | 63   | 192.3 | 179.3 |
| 24   | 17.6 | 16.4 | 84   | 61.4 | 57.3 | 44   | 105.3 | 98.2  | 04   | 149.2 | 139.1 | 64   | 193.1 | 180.0 |
| 25   | 18.3 | 17.1 | 85   | 62.2 | 58.0 | 45   | 106.0 | 98.9  | 05   | 149.9 | 139.8 | 65   | 193.8 | 180.7 |
| 26   | 19.0 | 17.7 | 86   | 62.9 | 58.6 | 46   | 106.8 | 99.5  | 06   | 150.7 | 140.5 | 66   | 194.5 | 181.4 |
| 27   | 19.7 | 18.4 | 87   | 63.6 | 59.3 | 47   | 107.5 | 100.2 | 07   | 151.4 | 141.2 | 67   | 195.3 | 182.1 |
| 28   | 20.5 | 19.1 | 88   | 64.4 | 60.0 | 48   | 108.2 | 100.9 | 08   | 152.1 | 141.8 | 68   | 196.0 | 182.7 |
| 29   | 21.2 | 19.8 | 89   | 65.1 | 60.7 | 49   | 109.0 | 101.6 | 09   | 152.9 | 142.5 | 69   | 196.7 | 183.4 |
| 30   | 21.9 | 20.5 | 90   | 65.8 | 61.4 | 50   | 109.7 | 102.3 | 10   | 153.6 | 143.2 | 70   | 197.5 | 184.1 |
| 31   | 22.7 | 21.2 | 91   | 66.5 | 62.1 | 51   | 110.4 | 103.0 | 211  | 154.3 | 143.9 | 271  | 198.2 | 184.8 |
| 32   | 23.4 | 21.8 | 92   | 67.3 | 62.7 | 52   | 111.2 | 103.6 | 12   | 155.0 | 144.5 | 72   | 198.9 | 185.5 |
| 33   | 24.1 | 22.5 | 93   | 68.0 | 63.4 | 53   | 111.9 | 104.3 | 13   | 155.8 | 145.2 | 73   | 199.7 | 186.2 |
| 34   | 24.9 | 23.2 | 94   | 68.7 | 64.1 | 54   | 112.6 | 105.0 | 14   | 156.5 | 145.9 | 74   | 200.4 | 186.8 |
| 35   | 25.6 | 23.9 | 95   | 69.5 | 64.8 | 55   | 113.4 | 105.7 | 15   | 157.2 | 146.6 | 75   | 201.1 | 187.5 |
| 36   | 26.3 | 24.5 | 96   | 70.2 | 65.5 | 56   | 114.1 | 106.4 | 16   | 158.0 | 147.3 | 76   | 201.9 | 188.2 |
| 37   | 27.1 | 25.2 | 97   | 70.9 | 66.2 | 57   | 114.8 | 107.1 | 17   | 158.7 | 148.0 | 77   | 202.6 | 188.9 |
| 38   | 27.8 | 25.9 | 98   | 71.7 | 66.8 | 58   | 115.6 | 107.7 | 18   | 159.4 | 148.6 | 78   | 203.3 | 189.5 |
| 39   | 28.5 | 26.6 | 99   | 72.4 | 67.5 | 59   | 116.3 | 108.4 | 19   | 160.2 | 149.3 | 79   | 204.0 | 190.2 |
| 40   | 29.3 | 27.3 | 100  | 73.1 | 68.2 | 60   | 117.0 | 109.1 | 20   | 160.9 | 150.0 | 80   | 204.8 | 190.9 |
| 41   | 30.0 | 28.0 | 101  | 73.9 | 68.9 | 61   | 117.7 | 109.8 | 221  | 161.6 | 150.7 | 281  | 205.5 | 191.6 |
| 42   | 30.7 | 28.6 | 02   | 74.6 | 69.5 | 62   | 118.5 | 110.5 | 22   | 162.4 | 151.4 | 82   | 206.2 | 192.3 |
| 43   | 31.4 | 29.3 | 03   | 75.3 | 70.2 | 63   | 119.2 | 111.2 | 23   | 163.1 | 152.1 | 83   | 207.0 | 193.0 |
| 44   | 32.2 | 30.0 | 04   | 76.1 | 70.9 | 64   | 119.9 | 111.8 | 24   | 163.8 | 152.7 | 84   | 207.7 | 193.6 |
| 45   | 32.9 | 30.7 | 05   | 76.8 | 71.6 | 65   | 120.7 | 112.5 | 25   | 164.6 | 153.4 | 85   | 208.4 | 194.3 |
| 46   | 33.6 | 31.4 | 06   | 77.5 | 72.3 | 66   | 121.4 | 113.2 | 26   | 165.3 | 154.1 | 86   | 209.2 | 195.0 |
| 47   | 34.4 | 32.1 | 07   | 78.3 | 73.0 | 67   | 122.1 | 113.9 | 27   | 166.0 | 154.8 | 87   | 209.9 | 195.7 |
| 48   | 35.1 | 32.7 | 08   | 79.0 | 73.6 | 68   | 122.9 | 114.5 | 28   | 166.7 | 155.5 | 88   | 210.6 | 196.4 |
| 49   | 35.8 | 33.4 | 09   | 79.7 | 74.3 | 69   | 123.6 | 115.2 | 29   | 167.5 | 156.2 | 89   | 211.4 | 197.1 |
| 50   | 36.6 | 34.1 | 10   | 80.4 | 75.0 | 70   | 124.3 | 115.9 | 30   | 168.2 | 156.8 | 90   | 212.1 | 197.7 |
| 51   | 37.3 | 34.8 | 11   | 81.2 | 75.7 | 71   | 125.1 | 116.6 | 231  | 168.9 | 157.5 | 291  | 212.8 | 198.4 |
| 52   | 38.0 | 35.5 | 12   | 81.9 | 76.4 | 72   | 125.8 | 117.3 | 32   | 169.7 | 158.2 | 92   | 213.6 | 199.1 |
| 53   | 38.8 | 36.2 | 13   | 82.6 | 77.1 | 73   | 126.5 | 118.0 | 33   | 170.4 | 158.9 | 93   | 214.3 | 199.8 |
| 54   | 39.5 | 36.8 | 14   | 83.4 | 77.7 | 74   | 127.3 | 118.6 | 34   | 171.1 | 159.5 | 94   | 215.0 | 200.5 |
| 55   | 40.2 | 37.5 | 15   | 84.1 | 78.4 | 75   | 128.0 | 119.3 | 35   | 171.9 | 160.2 | 95   | 215.7 | 201.2 |
| 56   | 41.0 | 38.2 | 16   | 84.8 | 79.1 | 76   | 128.7 | 120.0 | 36   | 172.6 | 160.9 | 96   | 216.5 | 201.8 |
| 57   | 41.7 | 38.9 | 17   | 85.6 | 79.8 | 77   | 129.4 | 120.7 | 37   | 173.3 | 161.6 | 97   | 217.2 | 202.5 |
| 58   | 42.4 | 39.5 | 18   | 86.3 | 80.5 | 78   | 130.2 | 121.4 | 38   | 174.1 | 162.3 | 98   | 218.0 | 203.2 |
| 59   | 43.1 | 40.2 | 19   | 87.0 | 81.2 | 79   | 130.9 | 122.1 | 39   | 174.8 | 163.0 | 99   | 218.7 | 203.9 |
| 60   | 43.9 | 40.9 | 20   | 87.8 | 81.8 | 180  | 131.6 | 122.7 | 240  | 175.5 | 163.6 | 300  | 219.4 | 204.6 |
| Dist | Dep  | Lat  | Dist | Dep  | Lat  | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  | Dist | Dep.  | Lat.  |

TABLE III. Difference of Latitude and Departure for 44 Degrees.

| Dist | Lat  | Dep  | Dist | Lat  | Dep  | Dist | Lat   | Dep   | Dist | Lat   | Dep   | Dist | Lat   | Dep   | Dist | Lat   | Dep   |
|------|------|------|------|------|------|------|-------|-------|------|-------|-------|------|-------|-------|------|-------|-------|
| 1    | 00.7 | 00.7 | 61   | 43.9 | 42.4 | 121  | 87.0  | 84.0  | 181  | 130.2 | 125.7 | 241  | 173.4 | 167.4 | 301  | 216.6 | 209.6 |
| 2    | 01.4 | 01.4 | 62   | 44.6 | 43.1 | 22   | 87.8  | 84.7  | 82   | 130.9 | 126.4 | 42   | 174.1 | 168.1 | 102  | 217.3 | 210.3 |
| 3    | 02.2 | 02.1 | 63   | 45.3 | 43.8 | 23   | 88.5  | 85.4  | 83   | 131.6 | 127.1 | 43   | 174.8 | 168.8 | 103  | 218.0 | 211.0 |
| 4    | 02.9 | 02.8 | 64   | 46.0 | 44.5 | 24   | 89.2  | 86.1  | 84   | 132.4 | 127.8 | 44   | 175.5 | 169.5 | 104  | 218.7 | 211.7 |
| 5    | 03.6 | 03.5 | 65   | 46.8 | 45.1 | 25   | 89.9  | 86.8  | 85   | 133.1 | 128.5 | 45   | 176.2 | 170.2 | 105  | 219.4 | 212.4 |
| 6    | 04.3 | 04.2 | 66   | 47.5 | 45.8 | 26   | 90.6  | 87.5  | 86   | 133.8 | 129.2 | 46   | 176.9 | 170.9 | 106  | 220.1 | 213.1 |
| 7    | 05.0 | 04.9 | 67   | 48.2 | 46.5 | 27   | 91.4  | 88.2  | 87   | 134.5 | 129.9 | 47   | 177.7 | 171.6 | 107  | 220.8 | 213.8 |
| 8    | 05.8 | 05.6 | 68   | 48.9 | 47.2 | 28   | 92.1  | 88.9  | 88   | 135.2 | 130.6 | 48   | 178.4 | 172.3 | 108  | 221.5 | 214.5 |
| 9    | 06.5 | 06.3 | 69   | 49.6 | 47.9 | 29   | 92.8  | 89.6  | 89   | 135.9 | 131.3 | 49   | 179.1 | 173.0 | 109  | 222.2 | 215.2 |
| 10   | 07.2 | 06.9 | 70   | 50.3 | 48.6 | 30   | 93.5  | 90.3  | 90   | 136.7 | 132.0 | 50   | 179.8 | 173.6 | 110  | 222.9 | 215.9 |
| 11   | 07.9 | 07.6 | 71   | 51.1 | 49.3 | 31   | 94.2  | 91.0  | 91   | 137.4 | 132.7 | 51   | 180.5 | 174.3 | 111  | 223.6 | 216.6 |
| 12   | 08.6 | 08.3 | 72   | 51.8 | 50.0 | 32   | 94.9  | 91.7  | 92   | 138.1 | 133.4 | 52   | 181.3 | 175.0 | 112  | 224.3 | 217.3 |
| 13   | 09.4 | 09.0 | 73   | 52.5 | 50.7 | 33   | 95.7  | 92.4  | 93   | 138.8 | 134.1 | 53   | 182.0 | 175.7 | 113  | 225.0 | 218.0 |
| 14   | 10.1 | 09.7 | 74   | 53.2 | 51.4 | 34   | 96.4  | 93.1  | 94   | 139.5 | 134.8 | 54   | 182.7 | 176.4 | 114  | 225.7 | 218.7 |
| 15   | 10.8 | 10.4 | 75   | 53.9 | 52.1 | 35   | 97.1  | 93.8  | 95   | 140.3 | 135.5 | 55   | 183.4 | 177.1 | 115  | 226.4 | 219.4 |
| 16   | 11.5 | 11.1 | 76   | 54.7 | 52.8 | 36   | 97.8  | 94.5  | 96   | 141.0 | 136.1 | 56   | 184.1 | 177.8 | 116  | 227.1 | 220.1 |
| 17   | 12.2 | 11.8 | 77   | 55.4 | 53.5 | 37   | 98.5  | 95.2  | 97   | 141.7 | 136.8 | 57   | 184.9 | 178.5 | 117  | 227.8 | 220.8 |
| 18   | 12.9 | 12.5 | 78   | 56.1 | 54.2 | 38   | 99.3  | 95.9  | 98   | 142.4 | 137.5 | 58   | 185.6 | 179.2 | 118  | 228.5 | 221.5 |
| 19   | 13.7 | 13.2 | 79   | 56.8 | 54.9 | 39   | 100.0 | 96.5  | 99   | 143.1 | 138.2 | 59   | 186.3 | 179.9 | 119  | 229.2 | 222.2 |
| 20   | 14.4 | 13.9 | 80   | 57.5 | 55.6 | 40   | 100.7 | 97.2  | 200  | 143.9 | 138.9 | 60   | 187.0 | 180.6 | 120  | 229.9 | 222.9 |
| 21   | 15.1 | 14.6 | 81   | 58.3 | 56.3 | 41   | 101.4 | 97.9  | 201  | 144.6 | 139.6 | 61   | 187.7 | 181.3 | 121  | 230.6 | 223.6 |
| 22   | 15.8 | 15.3 | 82   | 59.0 | 57.0 | 42   | 102.1 | 98.6  | 02   | 145.3 | 140.3 | 62   | 188.4 | 182.0 | 122  | 231.3 | 224.3 |
| 23   | 16.5 | 16.0 | 83   | 59.7 | 57.7 | 43   | 102.9 | 99.3  | 03   | 146.0 | 141.0 | 63   | 189.2 | 182.7 | 123  | 232.0 | 225.0 |
| 24   | 17.3 | 16.7 | 84   | 60.4 | 58.3 | 44   | 103.6 | 100.0 | 04   | 146.7 | 141.7 | 64   | 189.9 | 183.4 | 124  | 232.7 | 225.7 |
| 25   | 18.0 | 17.4 | 85   | 61.1 | 59.0 | 45   | 104.3 | 100.7 | 05   | 147.5 | 142.4 | 65   | 190.6 | 184.1 | 125  | 233.4 | 226.4 |
| 26   | 18.7 | 18.1 | 86   | 61.9 | 59.7 | 46   | 105.0 | 101.4 | 06   | 148.2 | 143.1 | 66   | 191.3 | 184.8 | 126  | 234.1 | 227.1 |
| 27   | 19.4 | 18.8 | 87   | 62.6 | 60.4 | 47   | 105.7 | 102.1 | 07   | 148.9 | 143.8 | 67   | 192.1 | 185.5 | 127  | 234.8 | 227.8 |
| 28   | 20.1 | 19.4 | 88   | 63.3 | 61.1 | 48   | 106.5 | 102.8 | 08   | 149.6 | 144.5 | 68   | 192.8 | 186.2 | 128  | 235.5 | 228.5 |
| 29   | 20.9 | 20.1 | 89   | 64.0 | 61.8 | 49   | 107.2 | 103.5 | 09   | 150.3 | 145.2 | 69   | 193.5 | 186.9 | 129  | 236.2 | 229.2 |
| 30   | 21.6 | 20.8 | 90   | 64.7 | 62.5 | 50   | 107.9 | 104.2 | 10   | 151.1 | 145.9 | 70   | 194.2 | 187.6 | 130  | 236.9 | 229.9 |
| 31   | 22.3 | 21.5 | 91   | 65.5 | 63.2 | 151  | 108.6 | 104.9 | 211  | 151.8 | 146.6 | 71   | 194.9 | 188.3 | 131  | 237.6 | 230.6 |
| 32   | 23.0 | 22.2 | 92   | 66.2 | 63.9 | 52   | 109.3 | 105.6 | 12   | 152.5 | 147.3 | 72   | 195.6 | 189.0 | 132  | 238.3 | 231.3 |
| 33   | 23.7 | 22.9 | 93   | 66.9 | 64.6 | 53   | 110.1 | 106.3 | 13   | 153.2 | 147.9 | 73   | 196.4 | 189.7 | 133  | 239.0 | 232.0 |
| 34   | 24.5 | 23.6 | 94   | 67.6 | 65.3 | 54   | 110.8 | 107.0 | 14   | 153.9 | 148.6 | 74   | 197.1 | 190.4 | 134  | 239.7 | 232.7 |
| 35   | 25.2 | 24.3 | 95   | 68.3 | 66.0 | 55   | 111.5 | 107.7 | 15   | 154.6 | 149.3 | 75   | 197.8 | 191.1 | 135  | 240.4 | 233.4 |
| 36   | 25.9 | 25.0 | 96   | 69.1 | 66.7 | 56   | 112.2 | 108.4 | 16   | 155.4 | 150.0 | 76   | 198.5 | 191.8 | 136  | 241.1 | 234.1 |
| 37   | 26.6 | 25.7 | 97   | 69.8 | 67.4 | 57   | 112.9 | 109.1 | 17   | 156.1 | 150.7 | 77   | 199.2 | 192.5 | 137  | 241.8 | 234.8 |
| 38   | 27.3 | 26.4 | 98   | 70.5 | 68.1 | 58   | 113.7 | 109.7 | 18   | 156.8 | 151.4 | 78   | 200.0 | 193.2 | 138  | 242.5 | 235.5 |
| 39   | 28.1 | 27.1 | 99   | 71.2 | 68.8 | 59   | 114.4 | 110.4 | 19   | 157.5 | 152.1 | 79   | 200.7 | 193.9 | 139  | 243.2 | 236.2 |
| 40   | 28.8 | 27.8 | 100  | 71.9 | 69.5 | 60   | 115.1 | 111.1 | 20   | 158.2 | 152.8 | 80   | 201.4 | 194.6 | 140  | 243.9 | 236.9 |
| 41   | 29.5 | 28.5 | 101  | 72.6 | 70.2 | 161  | 115.8 | 111.8 | 221  | 159.0 | 153.5 | 281  | 202.1 | 195.3 | 141  | 244.6 | 237.6 |
| 42   | 30.2 | 29.2 | 02   | 73.4 | 70.8 | 62   | 116.5 | 112.5 | 22   | 159.7 | 154.2 | 82   | 202.8 | 196.0 | 142  | 245.3 | 238.3 |
| 43   | 30.9 | 29.9 | 03   | 74.1 | 71.5 | 63   | 117.2 | 113.2 | 23   | 160.4 | 154.9 | 83   | 203.6 | 196.7 | 143  | 246.0 | 239.0 |
| 44   | 31.6 | 30.6 | 04   | 74.8 | 72.2 | 64   | 118.0 | 113.9 | 24   | 161.1 | 155.6 | 84   | 204.3 | 197.4 | 144  | 246.7 | 239.7 |
| 45   | 32.4 | 31.3 | 05   | 75.5 | 72.9 | 65   | 118.7 | 114.6 | 25   | 161.8 | 156.3 | 85   | 205.0 | 198.1 | 145  | 247.4 | 240.4 |
| 46   | 33.1 | 32.0 | 06   | 76.2 | 73.6 | 66   | 119.4 | 115.3 | 26   | 162.6 | 157.0 | 86   | 205.7 | 198.8 | 146  | 248.1 | 241.1 |
| 47   | 33.8 | 32.6 | 07   | 77.0 | 74.3 | 67   | 120.1 | 116.0 | 27   | 163.3 | 157.7 | 87   | 206.4 | 199.5 | 147  | 248.8 | 241.8 |
| 48   | 34.5 | 33.3 | 08   | 77.7 | 75.0 | 68   | 120.8 | 116.7 | 28   | 164.0 | 158.4 | 88   | 207.2 | 200.2 | 148  | 249.5 | 242.5 |
| 49   | 35.2 | 34.0 | 09   | 78.4 | 75.7 | 69   | 121.6 | 117.4 | 29   | 164.7 | 159.1 | 89   | 207.9 | 200.9 | 149  | 250.2 | 243.2 |
| 50   | 36.0 | 34.7 | 10   | 79.1 | 76.4 | 70   | 122.3 | 118.1 | 30   | 165.4 | 159.8 | 90   | 208.6 | 201.6 | 150  | 250.9 | 243.9 |
| 51   | 36.7 | 35.4 | 111  | 79.8 | 77.1 | 171  | 123.0 | 118.8 | 231  | 166.2 | 160.4 | 291  | 209.3 | 202.3 | 151  | 251.6 | 244.6 |
| 52   | 37.4 | 36.1 | 12   | 80.6 | 77.8 | 72   | 123.7 | 119.5 | 32   | 166.9 | 161.1 | 92   | 210.0 | 203.0 | 152  | 252.3 | 245.3 |
| 53   | 38.1 | 36.8 | 13   | 81.3 | 78.5 | 73   | 124.4 | 120.2 | 33   | 167.6 | 161.8 | 93   | 210.8 | 203.7 | 153  | 253.0 | 246.0 |
| 54   | 38.8 | 37.5 | 14   | 82.0 | 79.2 | 74   | 125.2 | 120.9 | 34   | 168.3 | 162.5 | 94   | 211.5 | 204.4 | 154  | 253.7 | 246.7 |
| 55   | 39.6 | 38.2 | 15   | 82.7 | 79.9 | 75   | 125.9 | 121.6 | 35   | 169.0 | 163.2 | 95   | 212.2 | 205.1 | 155  | 254.4 | 247.4 |
| 56   | 40.3 | 38.9 | 16   | 83.4 | 80.6 | 76   | 126.6 | 122.3 | 36   | 169.8 | 163.9 | 96   | 212.9 | 205.8 | 156  | 255.1 | 248.1 |
| 57   | 41.0 | 39.6 | 17   | 84.2 | 81.3 | 77   | 127.3 | 122.9 | 37   | 170.5 | 164.6 | 97   | 213.6 | 206.5 | 157  | 255.8 | 248.8 |
| 58   | 41.7 | 40.3 | 18   | 84.9 | 82.0 | 78   | 128.0 | 123.6 | 38   | 171.2 | 165.3 | 98   | 214.4 | 207.2 | 158  | 256.5 | 249.5 |
| 59   | 42.4 | 41.0 | 19   | 85.6 | 82.7 | 79   | 128.8 | 124.3 | 39   | 171.9 | 166.0 | 99   | 215.1 | 207.9 | 159  | 257.2 | 250.2 |
| 60   | 43.2 | 41.7 | 120  | 86.3 | 83.4 | 180  | 129.5 | 125.0 | 240  | 172.6 | 166.7 | 300  | 215.8 | 208.6 | 160  | 257.9 | 250.9 |

for 46 Degrees.

TABLE III. Difference of Latitude and Departure for 45 Degrees.

| Dep.  | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat.  | Dep.  | Dist. | Lat.  | Dep.  | Dist. | Lat.  | Dep.  |
|-------|-------|------|------|-------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 167.4 | 1     | 00.7 | 00.7 | 61    | 43.1 | 43.1 | 121   | 85.6  | 85.6  | 181   | 128.0 | 128.0 | 241   | 170.4 | 170.4 |
| 168.1 | 2     | 01.4 | 01.4 | 62    | 43.8 | 43.8 | 22    | 86.3  | 86.3  | 82    | 128.7 | 128.7 | 42    | 171.1 | 171.1 |
| 168.8 | 3     | 02.1 | 02.1 | 63    | 44.5 | 44.5 | 23    | 87.0  | 87.0  | 83    | 129.4 | 129.4 | 43    | 171.8 | 171.8 |
| 169.5 | 4     | 02.8 | 02.8 | 64    | 45.3 | 45.3 | 24    | 87.7  | 87.7  | 84    | 130.1 | 130.1 | 44    | 172.5 | 172.5 |
| 170.2 | 5     | 03.5 | 03.5 | 65    | 46.0 | 46.0 | 25    | 88.4  | 88.4  | 85    | 130.8 | 130.8 | 45    | 173.2 | 173.2 |
| 170.9 | 6     | 04.2 | 04.2 | 66    | 46.7 | 46.7 | 26    | 89.1  | 89.1  | 86    | 131.5 | 131.5 | 46    | 173.9 | 173.9 |
| 171.6 | 7     | 04.9 | 04.9 | 67    | 47.4 | 47.4 | 27    | 89.8  | 89.8  | 87    | 132.2 | 132.2 | 47    | 174.6 | 174.6 |
| 172.3 | 8     | 05.7 | 05.7 | 68    | 48.1 | 48.1 | 28    | 90.5  | 90.5  | 88    | 132.9 | 132.9 | 48    | 175.4 | 175.4 |
| 173.0 | 9     | 06.4 | 06.4 | 69    | 48.8 | 48.8 | 29    | 91.2  | 91.2  | 89    | 133.6 | 133.6 | 49    | 176.1 | 176.1 |
| 173.7 | 10    | 07.1 | 07.1 | 70    | 49.5 | 49.5 | 30    | 91.9  | 91.9  | 90    | 134.3 | 134.3 | 50    | 176.8 | 176.8 |
| 174.4 | 11    | 07.8 | 07.8 | 71    | 50.2 | 50.2 | 131   | 92.7  | 92.7  | 191   | 135.1 | 135.1 | 251   | 177.5 | 177.5 |
| 175.1 | 12    | 08.5 | 08.5 | 72    | 50.9 | 50.9 | 32    | 93.3  | 93.3  | 92    | 135.8 | 135.8 | 52    | 178.2 | 178.2 |
| 175.8 | 13    | 09.2 | 09.2 | 73    | 51.6 | 51.6 | 33    | 94.0  | 94.0  | 93    | 136.5 | 136.5 | 53    | 178.9 | 178.9 |
| 176.5 | 14    | 09.9 | 09.9 | 74    | 52.3 | 52.3 | 34    | 94.7  | 94.7  | 94    | 137.2 | 137.2 | 54    | 179.6 | 179.6 |
| 177.2 | 15    | 10.6 | 10.6 | 75    | 53.0 | 53.0 | 35    | 95.5  | 95.5  | 95    | 137.9 | 137.9 | 55    | 180.3 | 180.3 |
| 177.9 | 16    | 11.3 | 11.3 | 76    | 53.7 | 53.7 | 36    | 96.2  | 96.2  | 96    | 138.6 | 138.6 | 56    | 181.0 | 181.0 |
| 178.6 | 17    | 12.0 | 12.0 | 77    | 54.4 | 54.4 | 37    | 96.9  | 96.9  | 97    | 139.3 | 139.3 | 57    | 181.7 | 181.7 |
| 179.3 | 18    | 12.7 | 12.7 | 78    | 55.2 | 55.2 | 38    | 97.6  | 97.6  | 98    | 140.0 | 140.0 | 58    | 182.4 | 182.4 |
| 180.0 | 19    | 13.4 | 13.4 | 79    | 55.9 | 55.9 | 39    | 98.3  | 98.3  | 99    | 140.7 | 140.7 | 59    | 183.1 | 183.1 |
| 180.7 | 20    | 14.1 | 14.1 | 80    | 56.6 | 56.6 | 40    | 99.0  | 99.0  | 200   | 141.4 | 141.4 | 60    | 183.8 | 183.8 |
| 181.4 | 21    | 14.8 | 14.8 | 81    | 57.3 | 57.3 | 141   | 99.7  | 99.7  | 201   | 142.1 | 142.1 | 261   | 184.5 | 184.5 |
| 182.1 | 22    | 15.6 | 15.6 | 82    | 58.0 | 58.0 | 42    | 100.4 | 100.4 | 02    | 142.8 | 142.8 | 62    | 185.3 | 185.3 |
| 182.8 | 23    | 16.3 | 16.3 | 83    | 58.7 | 58.7 | 43    | 101.1 | 101.1 | 03    | 143.5 | 143.5 | 63    | 186.0 | 186.0 |
| 183.5 | 24    | 17.0 | 17.0 | 84    | 59.4 | 59.4 | 44    | 101.8 | 101.8 | 04    | 144.2 | 144.2 | 64    | 186.7 | 186.7 |
| 184.2 | 25    | 17.7 | 17.7 | 85    | 60.1 | 60.1 | 45    | 102.5 | 102.5 | 05    | 144.9 | 144.9 | 65    | 187.4 | 187.4 |
| 184.9 | 26    | 18.4 | 18.4 | 86    | 60.8 | 60.8 | 46    | 103.2 | 103.2 | 06    | 145.7 | 145.7 | 66    | 188.1 | 188.1 |
| 185.6 | 27    | 19.1 | 19.1 | 87    | 61.5 | 61.5 | 47    | 103.9 | 103.9 | 07    | 146.4 | 146.4 | 67    | 188.8 | 188.8 |
| 186.3 | 28    | 19.8 | 19.8 | 88    | 62.2 | 62.2 | 48    | 104.6 | 104.6 | 08    | 147.1 | 147.1 | 68    | 189.5 | 189.5 |
| 187.0 | 29    | 20.5 | 20.5 | 89    | 62.9 | 62.9 | 49    | 105.4 | 105.4 | 09    | 147.8 | 147.8 | 69    | 190.2 | 190.2 |
| 187.7 | 30    | 21.2 | 21.2 | 90    | 63.6 | 63.6 | 50    | 106.1 | 106.1 | 10    | 148.5 | 148.5 | 70    | 190.9 | 190.9 |
| 188.4 | 31    | 21.9 | 21.9 | 91    | 64.3 | 64.3 | 151   | 106.8 | 106.8 | 211   | 149.2 | 149.2 | 271   | 191.6 | 191.6 |
| 189.1 | 32    | 22.6 | 22.6 | 92    | 65.1 | 65.1 | 52    | 107.5 | 107.5 | 12    | 149.9 | 149.9 | 72    | 192.3 | 192.3 |
| 189.8 | 33    | 23.3 | 23.3 | 93    | 65.8 | 65.8 | 53    | 108.2 | 108.2 | 13    | 150.6 | 150.6 | 73    | 193.0 | 193.0 |
| 190.5 | 34    | 24.0 | 24.0 | 94    | 66.5 | 66.5 | 54    | 108.9 | 108.9 | 14    | 151.3 | 151.3 | 74    | 193.7 | 193.7 |
| 191.2 | 35    | 24.7 | 24.7 | 95    | 67.2 | 67.2 | 55    | 109.6 | 109.6 | 15    | 152.0 | 152.0 | 75    | 194.4 | 194.4 |
| 191.9 | 36    | 25.5 | 25.5 | 96    | 67.9 | 67.9 | 56    | 110.3 | 110.3 | 16    | 152.7 | 152.7 | 76    | 195.2 | 195.2 |
| 192.6 | 37    | 26.2 | 26.2 | 97    | 68.6 | 68.6 | 57    | 111.0 | 111.0 | 17    | 153.4 | 153.4 | 77    | 195.9 | 195.9 |
| 193.3 | 38    | 26.9 | 26.9 | 98    | 69.3 | 69.3 | 58    | 111.7 | 111.7 | 18    | 154.1 | 154.1 | 78    | 196.6 | 196.6 |
| 194.0 | 39    | 27.6 | 27.6 | 99    | 70.0 | 70.0 | 59    | 112.4 | 112.4 | 19    | 154.8 | 154.8 | 79    | 197.3 | 197.3 |
| 194.7 | 40    | 28.3 | 28.3 | 100   | 70.7 | 70.7 | 60    | 113.1 | 113.1 | 20    | 155.6 | 155.6 | 80    | 198.0 | 198.0 |
| 195.4 | 41    | 29.0 | 29.0 | 101   | 71.4 | 71.4 | 161   | 113.8 | 113.8 | 221   | 156.3 | 156.3 | 281   | 198.7 | 198.7 |
| 196.1 | 42    | 29.7 | 29.7 | 02    | 72.1 | 72.1 | 62    | 114.5 | 114.5 | 22    | 157.0 | 157.0 | 82    | 199.4 | 199.4 |
| 196.8 | 43    | 30.4 | 30.4 | 03    | 72.8 | 72.8 | 63    | 115.3 | 115.3 | 23    | 157.7 | 157.7 | 83    | 200.1 | 200.1 |
| 197.5 | 44    | 31.1 | 31.1 | 04    | 73.5 | 73.5 | 64    | 116.0 | 116.0 | 24    | 158.4 | 158.4 | 84    | 200.8 | 200.8 |
| 198.2 | 45    | 31.8 | 31.8 | 05    | 74.2 | 74.2 | 65    | 116.7 | 116.7 | 25    | 159.1 | 159.1 | 85    | 201.5 | 201.5 |
| 198.9 | 46    | 32.5 | 32.5 | 06    | 74.9 | 74.9 | 66    | 117.4 | 117.4 | 26    | 159.8 | 159.8 | 86    | 202.2 | 202.2 |
| 199.6 | 47    | 33.2 | 33.2 | 07    | 75.7 | 75.7 | 67    | 118.1 | 118.1 | 27    | 160.5 | 160.5 | 87    | 202.9 | 202.9 |
| 200.3 | 48    | 33.9 | 33.9 | 08    | 76.4 | 76.4 | 68    | 118.8 | 118.8 | 28    | 161.2 | 161.2 | 88    | 203.6 | 203.6 |
| 201.0 | 49    | 34.6 | 34.6 | 09    | 77.1 | 77.1 | 69    | 119.5 | 119.5 | 29    | 161.9 | 161.9 | 89    | 204.3 | 204.3 |
| 201.7 | 50    | 35.4 | 35.4 | 10    | 77.8 | 77.8 | 70    | 120.2 | 120.2 | 30    | 162.6 | 162.6 | 90    | 205.1 | 205.1 |
| 202.4 | 51    | 36.1 | 36.1 | 111   | 78.5 | 78.5 | 171   | 120.9 | 120.9 | 231   | 163.3 | 163.3 | 291   | 205.8 | 205.8 |
| 203.1 | 52    | 36.8 | 36.8 | 12    | 79.2 | 79.2 | 72    | 121.6 | 121.6 | 32    | 164.0 | 164.0 | 92    | 206.5 | 206.5 |
| 203.8 | 53    | 37.5 | 37.5 | 13    | 79.9 | 79.9 | 73    | 122.3 | 122.3 | 33    | 164.7 | 164.7 | 93    | 207.2 | 207.2 |
| 204.5 | 54    | 38.2 | 38.2 | 14    | 80.6 | 80.6 | 74    | 123.0 | 123.0 | 34    | 165.5 | 165.5 | 94    | 207.9 | 207.9 |
| 205.2 | 55    | 38.9 | 38.9 | 15    | 81.3 | 81.3 | 75    | 123.7 | 123.7 | 35    | 166.2 | 166.2 | 95    | 208.6 | 208.6 |
| 205.9 | 56    | 39.6 | 39.6 | 16    | 82.0 | 82.0 | 76    | 124.4 | 124.4 | 36    | 166.9 | 166.9 | 96    | 209.3 | 209.3 |
| 206.6 | 57    | 40.3 | 40.3 | 17    | 82.7 | 82.7 | 77    | 125.2 | 125.2 | 37    | 167.6 | 167.6 | 97    | 210.0 | 210.0 |
| 207.3 | 58    | 41.0 | 41.0 | 18    | 83.4 | 83.4 | 78    | 125.9 | 125.9 | 38    | 168.3 | 168.3 | 98    | 210.7 | 210.7 |
| 208.0 | 59    | 41.7 | 41.7 | 19    | 84.1 | 84.1 | 79    | 126.6 | 126.6 | 39    | 169.0 | 169.0 | 99    | 211.4 | 211.4 |
| 208.7 | 60    | 42.4 | 42.4 | 120   | 84.8 | 84.8 | 180   | 127.3 | 127.3 | 240   | 169.7 | 169.7 | 300   | 212.1 | 212.1 |



TABLE IV.

Of Logarithmic Sines, Tangents, and Secants, to every Point  
and Quarter Point of the Compass.

| Points.         | Sines.    | Co-sines. | Tangent. | Co-tang.  | Secant.   | Co-secant | Points.         |
|-----------------|-----------|-----------|----------|-----------|-----------|-----------|-----------------|
| 0               | 0.00000   | 10.00000  | 0.00000  | Infinite. | 10.00000  | Infinite. | 8               |
| 0 $\frac{1}{4}$ | 8.69079   | 9.99947   | 8.69131  | 11.30867  | 10.00052  | 11.30921  | 7 $\frac{3}{4}$ |
| 0 $\frac{1}{2}$ | 8.99130   | 9.99790   | 8.99340  | 11.00660  | 10.00210  | 11.00870  | 7 $\frac{1}{2}$ |
| 0 $\frac{3}{4}$ | 9.16652   | 9.99527   | 9.17125  | 10.82875  | 10.00473  | 10.83348  | 7 $\frac{1}{4}$ |
| 1               | 9.29024   | 9.99157   | 9.29866  | 10.70134  | 10.00843  | 10.70976  | 7               |
| 1 $\frac{1}{4}$ | 9.38557   | 9.98679   | 9.39878  | 10.60122  | 10.01321  | 10.61443  | 6 $\frac{3}{4}$ |
| 1 $\frac{1}{2}$ | 9.46282   | 9.98088   | 9.48194  | 10.51806  | 10.01912  | 10.53718  | 6 $\frac{1}{2}$ |
| 1 $\frac{3}{4}$ | 9.52742   | 9.97385   | 9.55365  | 10.44635  | 10.02616  | 10.47258  | 6 $\frac{1}{4}$ |
| 2               | 9.58284   | 9.96562   | 9.61722  | 10.38278  | 10.03438  | 10.41716  | 6               |
| 2 $\frac{1}{4}$ | 9.63099   | 9.95616   | 9.67483  | 10.32517  | 10.04384  | 10.36901  | 5 $\frac{3}{4}$ |
| 2 $\frac{1}{2}$ | 9.67339   | 9.94543   | 9.72796  | 10.27204  | 10.05457  | 10.32661  | 5 $\frac{1}{2}$ |
| 2 $\frac{3}{4}$ | 9.71105   | 9.93335   | 9.77770  | 10.22230  | 10.06665  | 10.28895  | 5 $\frac{1}{4}$ |
| 3               | 9.74474   | 9.91985   | 9.82489  | 10.17511  | 10.08015  | 10.25526  | 5               |
| 3 $\frac{1}{4}$ | 9.77503   | 0.90483   | 9.87020  | 10.12980  | 10.09517  | 10.22497  | 4 $\frac{3}{4}$ |
| 3 $\frac{1}{2}$ | 9.80236   | 9.88819   | 9.91417  | 10.08583  | 10.11181  | 10.19764  | 4 $\frac{1}{2}$ |
| 3 $\frac{3}{4}$ | 9.82708   | 9.86979   | 9.95729  | 10.04270  | 10.13021  | 10.17292  | 4 $\frac{1}{4}$ |
| 4               | 9.84948   | 9.84948   | 10.00000 | 10.00000  | 10.15052  | 10.15052  | 4               |
|                 | Co-sines. | Sines.    | Co-tang. | Tangents  | Co-secant | Secant.   |                 |

A Table of Logarithms from 1 to 120.

| No. | Log.    | No. | Log.    | No. | Log.    | No. | Log.    | No. | Log.    | No. | Log.    |
|-----|---------|-----|---------|-----|---------|-----|---------|-----|---------|-----|---------|
| 1   | 0.00000 | 21  | 1.32222 | 41  | 1.61278 | 61  | 1.78533 | 81  | 1.90849 | 101 | 2.00433 |
| 2   | 30103   | 22  | 34242   | 42  | 62325   | 62  | 79239   | 82  | 91381   | 102 | 00866   |
| 3   | 47712   | 23  | 36173   | 43  | 63347   | 63  | 79934   | 83  | 91908   | 103 | 01288   |
| 4   | 60206   | 24  | 38021   | 44  | 64345   | 64  | 80618   | 84  | 92428   | 104 | 01709   |
| 5   | 69897   | 25  | 39794   | 45  | 65321   | 65  | 81291   | 85  | 92942   | 105 | 02119   |
| 6   | 77815   | 26  | 41497   | 46  | 66276   | 66  | 81954   | 86  | 93450   | 106 | 02533   |
| 7   | 84510   | 27  | 43136   | 47  | 67210   | 67  | 82607   | 87  | 93952   | 107 | 02939   |
| 8   | 90309   | 28  | 44716   | 48  | 68124   | 68  | 83251   | 88  | 94448   | 108 | 03344   |
| 9   | 95424   | 29  | 46240   | 49  | 69020   | 69  | 83885   | 89  | 94939   | 109 | 03749   |
| 10  | 00000   | 30  | 47712   | 50  | 69897   | 70  | 84510   | 90  | 95424   | 110 | 04153   |
| 11  | 1.04139 | 31  | 1.49136 | 51  | 1.70757 | 71  | 1.85126 | 91  | 1.95904 | 111 | 2.04533 |
| 12  | 07918   | 32  | 50515   | 52  | 71600   | 72  | 85733   | 92  | 96379   | 112 | 04922   |
| 13  | 11394   | 33  | 51851   | 53  | 72428   | 73  | 86332   | 93  | 96848   | 113 | 05309   |
| 14  | 14613   | 34  | 53148   | 54  | 73239   | 74  | 86923   | 94  | 97313   | 114 | 05699   |
| 15  | 17609   | 35  | 54407   | 55  | 74036   | 75  | 87506   | 95  | 97772   | 115 | 06077   |
| 16  | 20412   | 36  | 55630   | 56  | 74819   | 76  | 88081   | 96  | 98227   | 116 | 06444   |
| 17  | 23045   | 37  | 56820   | 57  | 75587   | 77  | 88649   | 97  | 98677   | 117 | 06811   |
| 18  | 25527   | 38  | 57978   | 58  | 76343   | 78  | 89209   | 98  | 99123   | 118 | 07181   |
| 19  | 27875   | 39  | 59106   | 59  | 77085   | 79  | 89763   | 99  | 99564   | 119 | 07555   |
| 20  | 30103   | 40  | 60206   | 60  | 77815   | 80  | 90309   | 100 | 2.00000 | 120 | 07199   |

TABLE IV.

A Table of Logarithms from 1 to 10,000.

| No. | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|-----|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 100 | 2.00000 | 2.00043 | 2.00087 | 2.00130 | 2.00173 | 2.00217 | 2.00260 | 2.00303 | 2.00346 | 2.00389 |
| 01  | 00432   | 00475   | 00518   | 00561   | 00604   | 00647   | 00689   | 00732   | 00775   | 00817   |
| 02  | 00860   | 00903   | 00945   | 00988   | 01030   | 01072   | 01115   | 01157   | 01199   | 01242   |
| 03  | 01284   | 01326   | 01368   | 01410   | 01452   | 01494   | 01536   | 01578   | 01620   | 01661   |
| 04  | 01703   | 01745   | 01787   | 01828   | 01870   | 01912   | 01953   | 01995   | 02036   | 02078   |
| 05  | 02119   | 02160   | 02202   | 02243   | 02284   | 02325   | 02366   | 02407   | 02449   | 02490   |
| 06  | 02531   | 02572   | 02612   | 02653   | 02694   | 02735   | 02776   | 02816   | 02857   | 02898   |
| 07  | 02938   | 02979   | 03019   | 03060   | 03100   | 03141   | 03181   | 03222   | 03262   | 03302   |
| 08  | 03342   | 03383   | 03423   | 03463   | 03503   | 03543   | 03583   | 03623   | 03663   | 03703   |
| 09  | 03743   | 03782   | 03822   | 03862   | 03902   | 03941   | 03981   | 04021   | 04060   | 04100   |
| 10  | 2.04139 | 2.04179 | 2.04218 | 2.04258 | 2.04297 | 2.04336 | 2.04376 | 2.04415 | 2.04454 | 2.04493 |
| 11  | 04532   | 04571   | 04610   | 04650   | 04689   | 04727   | 04766   | 04805   | 04844   | 04883   |
| 12  | 04922   | 04961   | 04999   | 05038   | 05077   | 05115   | 05154   | 05192   | 05231   | 05269   |
| 13  | 05308   | 05346   | 05385   | 05423   | 05461   | 05500   | 05538   | 05576   | 05614   | 05652   |
| 14  | 05690   | 05729   | 05767   | 05805   | 05843   | 05881   | 05918   | 05956   | 05994   | 06032   |
| 15  | 06070   | 06108   | 06145   | 06183   | 06221   | 06258   | 06296   | 06333   | 06371   | 06408   |
| 16  | 06446   | 06483   | 06521   | 06558   | 06595   | 06633   | 06670   | 06707   | 06744   | 06781   |
| 17  | 06819   | 06856   | 06893   | 06930   | 06967   | 07004   | 07041   | 07078   | 07115   | 07151   |
| 18  | 07188   | 07225   | 07262   | 07298   | 07335   | 07372   | 07408   | 07445   | 07482   | 07518   |
| 19  | 07555   | 07591   | 07628   | 07664   | 07700   | 07737   | 07773   | 07809   | 07846   | 07882   |
| 20  | 2.07918 | 2.07954 | 2.07990 | 2.08027 | 2.08063 | 2.08099 | 2.08135 | 2.08171 | 2.08207 | 2.08243 |
| 21  | 08279   | 08314   | 08350   | 08386   | 08422   | 08458   | 08493   | 08529   | 08565   | 08600   |
| 22  | 08636   | 08672   | 08707   | 08743   | 08778   | 08814   | 08849   | 08884   | 08920   | 08955   |
| 23  | 08991   | 09026   | 09061   | 09096   | 09132   | 09167   | 09202   | 09237   | 09272   | 09307   |
| 24  | 09342   | 09377   | 09412   | 09447   | 09482   | 09517   | 09552   | 09587   | 09621   | 09656   |
| 25  | 09691   | 09726   | 09760   | 09795   | 09830   | 09864   | 09899   | 09934   | 09968   | 10003   |
| 26  | 10037   | 10072   | 10106   | 10140   | 10175   | 10209   | 10243   | 10278   | 10312   | 10346   |
| 27  | 10380   | 10415   | 10449   | 10483   | 10517   | 10551   | 10585   | 10619   | 10653   | 10687   |
| 28  | 10721   | 10755   | 10789   | 10823   | 10857   | 10890   | 10924   | 10958   | 10992   | 11025   |
| 29  | 11059   | 11093   | 11126   | 11160   | 11193   | 11227   | 11260   | 11294   | 11327   | 11361   |
| 30  | 2.11394 | 2.11428 | 2.11461 | 2.11494 | 2.11528 | 2.11561 | 2.11594 | 2.11628 | 2.11661 | 2.11694 |
| 31  | 11727   | 11760   | 11793   | 11826   | 11860   | 11893   | 11926   | 11959   | 11992   | 12024   |
| 32  | 12057   | 12090   | 12123   | 12156   | 12189   | 12222   | 12254   | 12287   | 12320   | 12352   |
| 33  | 12383   | 12418   | 12450   | 12483   | 12516   | 12548   | 12581   | 12613   | 12646   | 12678   |
| 34  | 12710   | 12743   | 12775   | 12808   | 12840   | 12872   | 12905   | 12937   | 12969   | 13001   |
| 35  | 13033   | 13066   | 13098   | 13130   | 13162   | 13194   | 13226   | 13258   | 13290   | 13322   |
| 36  | 13354   | 13386   | 13418   | 13450   | 13481   | 13513   | 13545   | 13577   | 13609   | 13640   |
| 37  | 13672   | 13704   | 13735   | 13767   | 13799   | 13830   | 13862   | 13893   | 13925   | 13956   |
| 38  | 13988   | 14019   | 14051   | 14082   | 14114   | 14145   | 14176   | 14208   | 14239   | 14270   |
| 39  | 14301   | 14333   | 14364   | 14395   | 14426   | 14457   | 14489   | 14520   | 14551   | 14582   |
| 40  | 2.14613 | 2.14644 | 2.14675 | 2.14706 | 2.14737 | 2.14768 | 2.14799 | 2.14829 | 2.14860 | 2.14891 |
| 41  | 14922   | 14953   | 14983   | 15014   | 15045   | 15076   | 15106   | 15137   | 15168   | 15198   |
| 42  | 15229   | 15259   | 15290   | 15320   | 15351   | 15381   | 15412   | 15442   | 15473   | 15503   |
| 43  | 15534   | 15564   | 15594   | 15625   | 15655   | 15685   | 15715   | 15746   | 15776   | 15806   |
| 44  | 15836   | 15866   | 15897   | 15927   | 15957   | 15987   | 16017   | 16047   | 16077   | 16107   |
| 45  | 16137   | 16167   | 16197   | 16227   | 16256   | 16286   | 16316   | 16346   | 16376   | 16406   |
| 46  | 16435   | 16465   | 16495   | 16524   | 16554   | 16584   | 16613   | 16643   | 16673   | 16702   |
| 47  | 16732   | 16761   | 16791   | 16820   | 16850   | 16879   | 16909   | 16938   | 16967   | 16997   |
| 48  | 17026   | 17056   | 17085   | 17114   | 17143   | 17173   | 17202   | 17231   | 17260   | 17289   |
| 49  | 17319   | 17348   | 17377   | 17406   | 17435   | 17464   | 17493   | 17522   | 17551   | 17580   |
| 50  | 2.17609 | 2.17638 | 2.17667 | 2.17696 | 2.17725 | 2.17754 | 2.17782 | 2.17811 | 2.17840 | 2.17869 |
| 51  | 17898   | 17926   | 17955   | 17984   | 18013   | 18041   | 18070   | 18099   | 18127   | 18156   |
| 52  | 18184   | 18213   | 18241   | 18270   | 18298   | 18327   | 18355   | 18384   | 18412   | 18441   |
| 53  | 18469   | 18498   | 18526   | 18554   | 18583   | 18611   | 18639   | 18667   | 18696   | 18724   |
| 54  | 18752   | 18780   | 18808   | 18837   | 18865   | 18893   | 18921   | 18949   | 18977   | 19005   |
| 55  | 19033   | 19061   | 19089   | 19117   | 19145   | 19173   | 19201   | 19229   | 19257   | 19285   |
| 56  | 19312   | 19340   | 19368   | 19396   | 19424   | 19451   | 19479   | 19507   | 19535   | 19562   |
| 57  | 19590   | 19618   | 19645   | 19673   | 19700   | 19728   | 19756   | 19783   | 19811   | 19838   |
| 58  | 19866   | 19893   | 19921   | 19948   | 19976   | 20003   | 20030   | 20058   | 20085   | 20112   |
| 59  | 20140   | 20167   | 20194   | 20222   | 20249   | 20276   | 20303   | 20330   | 20358   | 20385   |

TABLE IV.

A Table of Logarithms from 1 to 10,000.

| N <sup>o</sup> | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|----------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 160            | 2.20412 | 2.20439 | 2.20466 | 2.20493 | 2.20520 | 2.20548 | 2.20575 | 2.20602 | 2.20629 | 2.20656 |
| 61             | 20683   | 20710   | 20737   | 20763   | 20790   | 20817   | 20844   | 20871   | 20898   | 20925   |
| 62             | 20951   | 20978   | 21005   | 21032   | 21059   | 21085   | 21112   | 21139   | 21165   | 21192   |
| 63             | 21219   | 21245   | 21272   | 21299   | 21325   | 21352   | 21378   | 21405   | 21431   | 21458   |
| 64             | 21484   | 21511   | 21537   | 21564   | 21590   | 21617   | 21643   | 21669   | 21696   | 21722   |
| 65             | 21748   | 21775   | 21801   | 21827   | 21854   | 21880   | 21906   | 21932   | 21958   | 21985   |
| 66             | 22011   | 22037   | 22063   | 22089   | 22115   | 22141   | 22167   | 22194   | 22220   | 22246   |
| 67             | 22272   | 22298   | 22324   | 22350   | 22376   | 22401   | 22427   | 22453   | 22479   | 22505   |
| 68             | 22531   | 22557   | 22583   | 22608   | 22634   | 22660   | 22686   | 22712   | 22737   | 22763   |
| 69             | 22789   | 22814   | 22840   | 22866   | 22891   | 22917   | 22943   | 22968   | 22994   | 23019   |
| 170            | 2.23045 | 2.23070 | 2.23096 | 2.23121 | 2.23147 | 2.23172 | 2.23198 | 2.23223 | 2.23249 | 2.23274 |
| 71             | 23300   | 23325   | 23350   | 23376   | 23401   | 23426   | 23452   | 23477   | 23502   | 23528   |
| 72             | 23553   | 23578   | 23603   | 23629   | 23654   | 23679   | 23704   | 23729   | 23754   | 23779   |
| 73             | 23805   | 23830   | 23855   | 23880   | 23905   | 23930   | 23955   | 23980   | 24005   | 24030   |
| 74             | 24055   | 24080   | 24105   | 24130   | 24155   | 24180   | 24204   | 24229   | 24254   | 24279   |
| 75             | 24304   | 24329   | 24353   | 24378   | 24403   | 24428   | 24452   | 24477   | 24502   | 24527   |
| 76             | 24551   | 24576   | 24601   | 24625   | 24650   | 24674   | 24699   | 24724   | 24748   | 24773   |
| 77             | 24797   | 24822   | 24846   | 24871   | 24895   | 24920   | 24944   | 24969   | 24993   | 25018   |
| 78             | 25042   | 25066   | 25091   | 25115   | 25139   | 25164   | 25188   | 25212   | 25237   | 25261   |
| 79             | 25285   | 25310   | 25334   | 25358   | 25382   | 25406   | 25431   | 25455   | 25479   | 25503   |
| 180            | 2.25527 | 2.25551 | 2.25575 | 2.25600 | 2.25624 | 2.25648 | 2.25672 | 2.25696 | 2.25720 | 2.25744 |
| 81             | 25768   | 25792   | 25816   | 25840   | 25864   | 25888   | 25912   | 25935   | 25959   | 25983   |
| 82             | 26007   | 26031   | 26055   | 26079   | 26102   | 26126   | 26150   | 26174   | 26198   | 26222   |
| 83             | 26245   | 26269   | 26292   | 26316   | 26340   | 26364   | 26387   | 26411   | 26434   | 26458   |
| 84             | 26482   | 26505   | 26529   | 26553   | 26576   | 26600   | 26623   | 26647   | 26670   | 26694   |
| 85             | 26717   | 26741   | 26764   | 26788   | 26811   | 26834   | 26858   | 26881   | 26905   | 26928   |
| 86             | 26951   | 26975   | 26998   | 27021   | 27045   | 27068   | 27091   | 27114   | 27138   | 27161   |
| 87             | 27184   | 27207   | 27231   | 27254   | 27277   | 27300   | 27323   | 27346   | 27370   | 27393   |
| 88             | 27416   | 27439   | 27462   | 27485   | 27508   | 27531   | 27554   | 27577   | 27600   | 27623   |
| 89             | 27646   | 27669   | 27692   | 27715   | 27738   | 27761   | 27784   | 27807   | 27830   | 27853   |
| 190            | 2.27875 | 2.27898 | 2.27921 | 2.27944 | 2.27967 | 2.27989 | 2.28012 | 2.28035 | 2.28058 | 2.28081 |
| 91             | 28103   | 28126   | 28149   | 28171   | 28194   | 28217   | 28240   | 28262   | 28285   | 28307   |
| 92             | 28330   | 28353   | 28375   | 28398   | 28421   | 28443   | 28466   | 28488   | 28511   | 28533   |
| 93             | 28556   | 28578   | 28601   | 28623   | 28646   | 28668   | 28691   | 28713   | 28735   | 28758   |
| 94             | 28780   | 28803   | 28825   | 28847   | 28870   | 28892   | 28914   | 28937   | 28959   | 28981   |
| 95             | 29003   | 29026   | 29048   | 29070   | 29092   | 29115   | 29137   | 29159   | 29181   | 29203   |
| 96             | 29226   | 29248   | 29270   | 29292   | 29314   | 29336   | 29358   | 29380   | 29403   | 29425   |
| 97             | 29447   | 29469   | 29491   | 29513   | 29535   | 29557   | 29579   | 29601   | 29623   | 29645   |
| 98             | 29667   | 29688   | 29710   | 29732   | 29754   | 29776   | 29798   | 29820   | 29842   | 29863   |
| 99             | 29885   | 29907   | 29929   | 29951   | 29973   | 29994   | 30016   | 30038   | 30060   | 30081   |
| 200            | 2.30103 | 2.3012  | 2.30146 | 2.30168 | 2.30190 | 2.30211 | 2.30233 | 2.30255 | 2.30276 | 2.30298 |
| 01             | 30320   | 30341   | 30363   | 30384   | 30406   | 30428   | 30449   | 30471   | 30492   | 30514   |
| 02             | 30535   | 30557   | 30578   | 30600   | 30621   | 30643   | 30664   | 30685   | 30707   | 30728   |
| 03             | 30750   | 30771   | 30792   | 30814   | 30835   | 30856   | 30878   | 30899   | 30920   | 30941   |
| 04             | 30963   | 30984   | 31006   | 31027   | 31048   | 31069   | 31091   | 31112   | 31133   | 31154   |
| 05             | 31175   | 31197   | 31218   | 31239   | 31260   | 31281   | 31302   | 31323   | 31345   | 31366   |
| 06             | 31387   | 31408   | 31429   | 31450   | 31471   | 31492   | 31513   | 31534   | 31555   | 31576   |
| 07             | 31597   | 31618   | 31639   | 31660   | 31681   | 31702   | 31723   | 31744   | 31765   | 31785   |
| 08             | 31806   | 31827   | 31848   | 31869   | 31890   | 31911   | 31931   | 31952   | 31973   | 31994   |
| 09             | 32015   | 32035   | 32056   | 32077   | 32098   | 32118   | 32139   | 32160   | 32181   | 32201   |
| 210            | 2.32222 | 2.32243 | 2.32263 | 2.32284 | 2.32305 | 2.32325 | 2.32346 | 2.32366 | 2.32387 | 2.32408 |
| 11             | 32428   | 32449   | 32469   | 32490   | 32510   | 32531   | 32552   | 32572   | 32593   | 32613   |
| 12             | 32634   | 32654   | 32675   | 32695   | 32715   | 32736   | 32756   | 32777   | 32797   | 32818   |
| 13             | 32838   | 32858   | 32879   | 32899   | 32919   | 32940   | 32960   | 32980   | 33001   | 33021   |
| 14             | 33041   | 33062   | 33082   | 33102   | 33122   | 33143   | 33163   | 33185   | 33203   | 33224   |
| 15             | 33244   | 33264   | 33284   | 33304   | 33325   | 33345   | 33365   | 33385   | 33405   | 33425   |
| 16             | 33445   | 33465   | 33486   | 33506   | 33526   | 33546   | 33566   | 33586   | 33606   | 33626   |
| 17             | 33646   | 33666   | 33686   | 33706   | 33726   | 33746   | 33766   | 33786   | 33806   | 33826   |
| 18             | 33846   | 33866   | 33885   | 33905   | 33925   | 33945   | 33965   | 33985   | 34005   | 34025   |
| 219            | 34044   | 34064   | 34084   | 34104   | 34124   | 34143   | 34163   | 34183   | 34203   | 34223   |



TABLE IV.

A Table of Logarithms from 1 to 10,000.

| No | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|----|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 0  | 2.34242 | 2.34262 | 2.34282 | 2.34301 | 2.34321 | 2.34341 | 2.34361 | 2.34380 | 2.34400 | 2.34420 |
| 1  | 34439   | 34459   | 34479   | 34498   | 34518   | 34537   | 34557   | 34577   | 34596   | 34616   |
| 2  | 34635   | 34655   | 34674   | 34694   | 34713   | 34733   | 34753   | 34772   | 34792   | 34811   |
| 3  | 34830   | 34850   | 34869   | 34889   | 34908   | 34928   | 34947   | 34967   | 34986   | 35005   |
| 4  | 35025   | 35044   | 35064   | 35083   | 35102   | 35122   | 35141   | 35160   | 35180   | 35199   |
| 5  | 35218   | 35238   | 35257   | 35276   | 35295   | 35315   | 35334   | 35353   | 35372   | 35392   |
| 6  | 35411   | 35430   | 35449   | 35468   | 35488   | 35507   | 35526   | 35545   | 35564   | 35583   |
| 7  | 35603   | 35622   | 35641   | 35660   | 35679   | 35698   | 35717   | 35736   | 35755   | 35774   |
| 8  | 35793   | 35813   | 35832   | 35851   | 35870   | 35889   | 35908   | 35927   | 35946   | 35965   |
| 9  | 35984   | 36003   | 36021   | 36040   | 36059   | 36078   | 36097   | 36116   | 36135   | 36154   |
| 10 | 2.36173 | 2.36192 | 2.36211 | 2.36229 | 2.36248 | 2.36267 | 2.36286 | 2.36305 | 2.36324 | 2.36342 |
| 11 | 36361   | 36380   | 36399   | 36418   | 36436   | 36455   | 36474   | 36493   | 36511   | 36530   |
| 12 | 36549   | 36568   | 36586   | 36605   | 36624   | 36642   | 36661   | 36680   | 36698   | 36717   |
| 13 | 36736   | 36754   | 36773   | 36791   | 36810   | 36829   | 36847   | 36866   | 36884   | 36903   |
| 14 | 36922   | 36940   | 36959   | 36977   | 36996   | 37014   | 37033   | 37051   | 37070   | 37088   |
| 15 | 37107   | 37125   | 37144   | 37162   | 37181   | 37199   | 37218   | 37236   | 37254   | 37273   |
| 16 | 37291   | 37310   | 37328   | 37346   | 37365   | 37383   | 37401   | 37420   | 37438   | 37457   |
| 17 | 37475   | 37493   | 37511   | 37530   | 37548   | 37566   | 37585   | 37603   | 37621   | 37639   |
| 18 | 37658   | 37676   | 37694   | 37712   | 37731   | 37749   | 37767   | 37785   | 37803   | 37822   |
| 19 | 37840   | 37858   | 37876   | 37894   | 37912   | 37931   | 37949   | 37967   | 37985   | 38003   |
| 20 | 2.38021 | 2.38039 | 2.38057 | 2.38075 | 2.38093 | 2.38112 | 2.38130 | 2.38148 | 2.38166 | 2.38184 |
| 21 | 38202   | 38220   | 38238   | 38256   | 38274   | 38292   | 38310   | 38328   | 38346   | 38364   |
| 22 | 38382   | 38399   | 38417   | 38435   | 38453   | 38471   | 38489   | 38507   | 38525   | 38543   |
| 23 | 38561   | 38578   | 38596   | 38614   | 38632   | 38650   | 38668   | 38686   | 38703   | 38721   |
| 24 | 38739   | 38757   | 38775   | 38792   | 38810   | 38828   | 38846   | 38863   | 38881   | 38899   |
| 25 | 38917   | 38934   | 38952   | 38970   | 38987   | 39005   | 39023   | 39041   | 39058   | 39076   |
| 26 | 39094   | 39111   | 39129   | 39146   | 39164   | 39182   | 39199   | 39217   | 39235   | 39252   |
| 27 | 39270   | 39287   | 39305   | 39322   | 39340   | 39358   | 39375   | 39393   | 39410   | 39428   |
| 28 | 39445   | 39463   | 39480   | 39498   | 39515   | 39533   | 39550   | 39568   | 39585   | 39602   |
| 29 | 39620   | 39637   | 39655   | 39672   | 39690   | 39707   | 39724   | 39742   | 39759   | 39777   |
| 30 | 2.39794 | 2.39811 | 2.39829 | 2.39846 | 2.39863 | 2.39881 | 2.39898 | 2.39915 | 2.39933 | 2.39950 |
| 31 | 39967   | 39985   | 40002   | 40019   | 40037   | 40054   | 40071   | 40088   | 40106   | 40123   |
| 32 | 40140   | 40157   | 40175   | 40192   | 40209   | 40226   | 40243   | 40261   | 40278   | 40295   |
| 33 | 40312   | 40329   | 40346   | 40364   | 40381   | 40398   | 40415   | 40432   | 40449   | 40466   |
| 34 | 40483   | 40500   | 40518   | 40535   | 40552   | 40569   | 40586   | 40603   | 40620   | 40637   |
| 35 | 40654   | 40671   | 40688   | 40705   | 40722   | 40739   | 40756   | 40773   | 40790   | 40807   |
| 36 | 40824   | 40841   | 40858   | 40875   | 40892   | 40909   | 40926   | 40943   | 40959   | 40976   |
| 37 | 40993   | 41010   | 41027   | 41044   | 41061   | 41078   | 41095   | 41111   | 41128   | 41145   |
| 38 | 41162   | 41179   | 41196   | 41212   | 41229   | 41246   | 41263   | 41280   | 41296   | 41313   |
| 39 | 41330   | 41347   | 41363   | 41380   | 41397   | 41414   | 41430   | 41447   | 41464   | 41481   |
| 40 | 2.41497 | 2.41514 | 2.41531 | 2.41547 | 2.41564 | 2.41581 | 2.41597 | 2.41614 | 2.41631 | 2.41647 |
| 41 | 41664   | 41681   | 41697   | 41714   | 41731   | 41747   | 41764   | 41780   | 41797   | 41814   |
| 42 | 41830   | 41847   | 41863   | 41880   | 41896   | 41913   | 41929   | 41946   | 41963   | 41979   |
| 43 | 41996   | 42012   | 42029   | 42045   | 42062   | 42078   | 42095   | 42111   | 42127   | 42144   |
| 44 | 42160   | 42177   | 42193   | 42210   | 42226   | 42243   | 42259   | 42275   | 42292   | 42308   |
| 45 | 42325   | 42341   | 42357   | 42374   | 42390   | 42406   | 42423   | 42439   | 42455   | 42472   |
| 46 | 42488   | 42504   | 42521   | 42537   | 42553   | 42570   | 42586   | 42602   | 42619   | 42635   |
| 47 | 42651   | 42667   | 42684   | 42700   | 42716   | 42732   | 42749   | 42765   | 42781   | 42797   |
| 48 | 42813   | 42830   | 42846   | 42862   | 42878   | 42894   | 42911   | 42927   | 42943   | 42959   |
| 49 | 42975   | 42991   | 43008   | 43024   | 43040   | 43056   | 43072   | 43088   | 43104   | 43120   |
| 50 | 2.43136 | 2.43152 | 2.43169 | 2.43185 | 2.43201 | 2.43217 | 2.43233 | 2.43249 | 2.43265 | 2.43281 |
| 51 | 43297   | 43313   | 43329   | 43345   | 43361   | 43377   | 43393   | 43409   | 43425   | 43441   |
| 52 | 43457   | 43473   | 43489   | 43505   | 43521   | 43537   | 43553   | 43569   | 43584   | 43600   |
| 53 | 43616   | 43632   | 43648   | 43664   | 43680   | 43696   | 43712   | 43727   | 43743   | 43759   |
| 54 | 43775   | 43791   | 43807   | 43823   | 43838   | 43854   | 43870   | 43886   | 43902   | 43917   |
| 55 | 43933   | 43949   | 43965   | 43981   | 43996   | 44012   | 44028   | 44044   | 44059   | 44075   |
| 56 | 44091   | 44107   | 44122   | 44138   | 44154   | 44170   | 44185   | 44201   | 44217   | 44232   |
| 57 | 44248   | 44264   | 44279   | 44295   | 44311   | 44326   | 44342   | 44358   | 44373   | 44389   |
| 58 | 44404   | 44420   | 44436   | 44451   | 44467   | 44483   | 44498   | 44514   | 44529   | 44545   |
| 59 | 44560   | 44576   | 44592   | 44607   | 44623   | 44638   | 44654   | 44669   | 44685   | 44700   |

TABLE IV.

A Table of Logarithms from 1 to 10,000.

| N <sup>o</sup> | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|----------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 280            | 2.44716 | 2.44731 | 2.44747 | 2.44762 | 2.44778 | 2.44793 | 2.44809 | 2.44824 | 2.44840 | 2.44855 |
| 81             | 44871   | 44886   | 44902   | 44917   | 44932   | 44948   | 44963   | 44979   | 44994   | 45010   |
| 82             | 45025   | 45040   | 45056   | 45071   | 45086   | 45102   | 45117   | 45133   | 45148   | 45164   |
| 83             | 45179   | 45194   | 45209   | 45225   | 45240   | 45255   | 45271   | 45286   | 45301   | 45317   |
| 84             | 45332   | 45347   | 45362   | 45378   | 45393   | 45408   | 45423   | 45439   | 45454   | 45470   |
| 85             | 45484   | 45500   | 45515   | 45530   | 45545   | 45561   | 45576   | 45591   | 45606   | 45622   |
| 86             | 45637   | 45652   | 45667   | 45682   | 45697   | 45712   | 45728   | 45743   | 45758   | 45774   |
| 87             | 45788   | 45803   | 45818   | 45834   | 45849   | 45864   | 45879   | 45894   | 45909   | 45925   |
| 88             | 45939   | 45954   | 45969   | 45984   | 46000   | 46015   | 46030   | 46045   | 46060   | 46076   |
| 89             | 46090   | 46105   | 46120   | 46135   | 46150   | 46165   | 46180   | 46195   | 46210   | 46226   |
| 290            | 2.46240 | 2.46255 | 2.46270 | 2.46285 | 2.46300 | 2.46315 | 2.46330 | 2.46344 | 2.46359 | 2.46374 |
| 91             | 46389   | 46404   | 46419   | 46434   | 46449   | 46464   | 46479   | 46494   | 46509   | 46524   |
| 92             | 46538   | 46553   | 46568   | 46583   | 46598   | 46613   | 46627   | 46642   | 46657   | 46672   |
| 93             | 46687   | 46702   | 46716   | 46731   | 46746   | 46761   | 46776   | 46790   | 46805   | 46820   |
| 94             | 46835   | 46849   | 46864   | 46879   | 46894   | 46909   | 46923   | 46938   | 46953   | 46968   |
| 95             | 46982   | 46997   | 47012   | 47026   | 47041   | 47056   | 47070   | 47085   | 47100   | 47115   |
| 96             | 47129   | 47144   | 47159   | 47173   | 47188   | 47202   | 47217   | 47232   | 47246   | 47261   |
| 97             | 47276   | 47290   | 47305   | 47319   | 47334   | 47349   | 47363   | 47378   | 47392   | 47407   |
| 98             | 47422   | 47436   | 47451   | 47465   | 47480   | 47494   | 47510   | 47524   | 47538   | 47553   |
| 99             | 47567   | 47582   | 47596   | 47611   | 47625   | 47640   | 47654   | 47669   | 47683   | 47698   |
| 300            | 2.47712 | 2.47727 | 2.47741 | 2.47756 | 2.47770 | 2.47784 | 2.47799 | 2.47813 | 2.47828 | 2.47842 |
| 01             | 47857   | 47871   | 47885   | 47900   | 47914   | 47929   | 47943   | 47958   | 47972   | 47987   |
| 02             | 48001   | 48015   | 48029   | 48044   | 48058   | 48073   | 48087   | 48101   | 48116   | 48130   |
| 03             | 48144   | 48159   | 48173   | 48187   | 48202   | 48216   | 48230   | 48244   | 48259   | 48273   |
| 04             | 48287   | 48302   | 48316   | 48330   | 48344   | 48359   | 48373   | 48387   | 48401   | 48416   |
| 05             | 48430   | 48444   | 48458   | 48473   | 48487   | 48501   | 48515   | 48530   | 48544   | 48558   |
| 06             | 48572   | 48586   | 48601   | 48615   | 48629   | 48643   | 48657   | 48671   | 48686   | 48700   |
| 07             | 48714   | 48728   | 48742   | 48756   | 48770   | 48785   | 48799   | 48813   | 48827   | 48841   |
| 08             | 48855   | 48869   | 48883   | 48897   | 48911   | 48926   | 48940   | 48954   | 48968   | 48982   |
| 09             | 48996   | 49010   | 49024   | 49038   | 49052   | 49066   | 49080   | 49094   | 49108   | 49122   |
| 310            | 2.49136 | 2.49150 | 2.49164 | 2.49178 | 2.49192 | 2.49206 | 2.49220 | 2.49234 | 2.49248 | 2.49262 |
| 11             | 49276   | 49290   | 49304   | 49318   | 49332   | 49346   | 49360   | 49374   | 49388   | 49402   |
| 12             | 49415   | 49429   | 49443   | 49457   | 49471   | 49485   | 49499   | 49513   | 49527   | 49541   |
| 13             | 49554   | 49568   | 49582   | 49596   | 49610   | 49624   | 49638   | 49651   | 49665   | 49679   |
| 14             | 49693   | 49707   | 49721   | 49734   | 49748   | 49762   | 49776   | 49790   | 49803   | 49817   |
| 15             | 49831   | 49845   | 49859   | 49872   | 49886   | 49900   | 49914   | 49927   | 49941   | 49954   |
| 16             | 49969   | 49982   | 49996   | 50010   | 50024   | 50037   | 50051   | 50065   | 50079   | 50092   |
| 17             | 50106   | 50120   | 50133   | 50147   | 50161   | 50174   | 50188   | 50202   | 50215   | 50229   |
| 18             | 50243   | 50256   | 50270   | 50284   | 50297   | 50311   | 50325   | 50338   | 50352   | 50365   |
| 19             | 50379   | 50393   | 50406   | 50420   | 50433   | 50447   | 50461   | 50474   | 50488   | 50501   |
| 320            | 2.50515 | 2.50529 | 2.50542 | 2.50556 | 2.50569 | 2.50583 | 2.50596 | 2.50610 | 2.50623 | 2.50637 |
| 21             | 50650   | 50664   | 50678   | 50691   | 50705   | 50718   | 50732   | 50745   | 50759   | 50772   |
| 22             | 50786   | 50799   | 50813   | 50826   | 50839   | 50853   | 50866   | 50880   | 50893   | 50907   |
| 23             | 50920   | 50934   | 50947   | 50961   | 50974   | 50987   | 51001   | 51014   | 51028   | 51041   |
| 24             | 51054   | 51068   | 51081   | 51095   | 51108   | 51121   | 51135   | 51148   | 51162   | 51175   |
| 25             | 51188   | 51202   | 51215   | 51228   | 51242   | 51255   | 51268   | 51282   | 51295   | 51309   |
| 26             | 51322   | 51335   | 51348   | 51362   | 51375   | 51388   | 51402   | 51415   | 51428   | 51442   |
| 27             | 51455   | 51468   | 51481   | 51495   | 51508   | 51521   | 51534   | 51548   | 51561   | 51575   |
| 28             | 51587   | 51601   | 51614   | 51627   | 51640   | 51654   | 51667   | 51680   | 51694   | 51707   |
| 29             | 51720   | 51733   | 51746   | 51759   | 51772   | 51786   | 51799   | 51812   | 51825   | 51839   |
| 330            | 2.51851 | 2.51865 | 2.51878 | 2.51891 | 2.51904 | 2.51917 | 2.51930 | 2.51943 | 2.51957 | 2.51970 |
| 31             | 51983   | 51996   | 52009   | 52022   | 52035   | 52048   | 52061   | 52075   | 52088   | 52101   |
| 32             | 52114   | 52127   | 52140   | 52153   | 52166   | 52179   | 52192   | 52205   | 52218   | 52231   |
| 33             | 52244   | 52257   | 52270   | 52284   | 52297   | 52310   | 52323   | 52336   | 52349   | 52362   |
| 34             | 52375   | 52388   | 52401   | 52414   | 52427   | 52440   | 52453   | 52466   | 52479   | 52492   |
| 35             | 52504   | 52517   | 52530   | 52543   | 52556   | 52569   | 52582   | 52595   | 52608   | 52621   |
| 36             | 52634   | 52647   | 52660   | 52673   | 52686   | 52699   | 52711   | 52724   | 52737   | 52750   |
| 37             | 52763   | 52776   | 52789   | 52802   | 52815   | 52827   | 52840   | 52853   | 52866   | 52879   |
| 38             | 52892   | 52905   | 52917   | 52930   | 52943   | 52956   | 52969   | 52982   | 52994   | 53007   |
| 39             | 53020   | 53033   | 53046   | 53058   | 53071   | 53084   | 53097   | 53110   | 53122   | 53135   |

TABLE IV.

A Table of Logarithms from 1 10,000.

|     | 0     | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 445 | 53148 | 53161 | 53173 | 53186 | 53199 | 53212 | 53224 | 53237 | 53250 | 53263 |
| 450 | 53275 | 53288 | 53301 | 53314 | 53326 | 53339 | 53352 | 53364 | 53377 | 53390 |
| 455 | 53403 | 53415 | 53428 | 53441 | 53453 | 53466 | 53479 | 53491 | 53504 | 53517 |
| 460 | 53529 | 53542 | 53555 | 53567 | 53580 | 53593 | 53605 | 53618 | 53631 | 53643 |
| 465 | 53656 | 53668 | 53681 | 53694 | 53706 | 53719 | 53732 | 53744 | 53757 | 53769 |
| 470 | 53782 | 53794 | 53807 | 53820 | 53832 | 53845 | 53857 | 53870 | 53882 | 53895 |
| 475 | 53908 | 53920 | 53933 | 53945 | 53958 | 53970 | 53983 | 53995 | 54008 | 54020 |
| 480 | 54033 | 54045 | 54058 | 54070 | 54083 | 54095 | 54108 | 54120 | 54133 | 54145 |
| 485 | 54158 | 54170 | 54183 | 54195 | 54208 | 54220 | 54233 | 54245 | 54258 | 54270 |
| 490 | 54183 | 54295 | 54307 | 54320 | 54332 | 54345 | 54357 | 54370 | 54382 | 54394 |
| 495 | 54407 | 54419 | 54432 | 54444 | 54456 | 54469 | 54481 | 54494 | 54506 | 54518 |
| 500 | 54531 | 54543 | 54555 | 54568 | 54580 | 54592 | 54605 | 54617 | 54630 | 54642 |
| 505 | 54654 | 54667 | 54679 | 54691 | 54704 | 54716 | 54728 | 54741 | 54753 | 54765 |
| 510 | 54777 | 54790 | 54802 | 54814 | 54827 | 54839 | 54851 | 54864 | 54876 | 54888 |
| 515 | 54900 | 54913 | 54925 | 54937 | 54949 | 54962 | 54974 | 54986 | 54998 | 55011 |
| 520 | 55023 | 55035 | 55047 | 55060 | 55072 | 55084 | 55096 | 55108 | 55121 | 55133 |
| 525 | 55145 | 55157 | 55169 | 55182 | 55194 | 55206 | 55218 | 55230 | 55242 | 55255 |
| 530 | 55267 | 55279 | 55291 | 55303 | 55315 | 55328 | 55340 | 55352 | 55364 | 55376 |
| 535 | 55388 | 55400 | 55413 | 55425 | 55437 | 55449 | 55461 | 55473 | 55485 | 55497 |
| 540 | 55509 | 55522 | 55534 | 55546 | 55558 | 55570 | 55582 | 55594 | 55606 | 55618 |
| 545 | 55630 | 55642 | 55654 | 55666 | 55678 | 55691 | 55703 | 55715 | 55727 | 55739 |
| 550 | 55751 | 55763 | 55775 | 55787 | 55799 | 55811 | 55823 | 55835 | 55847 | 55859 |
| 555 | 55871 | 55883 | 55895 | 55907 | 55919 | 55931 | 55943 | 55955 | 55967 | 55979 |
| 560 | 55991 | 56003 | 56015 | 56027 | 56038 | 56050 | 56062 | 56074 | 56086 | 56098 |
| 565 | 56110 | 56122 | 56134 | 56146 | 56158 | 56170 | 56182 | 56194 | 56205 | 56217 |
| 570 | 56229 | 56241 | 56253 | 56265 | 56277 | 56289 | 56301 | 56312 | 56324 | 56336 |
| 575 | 56348 | 56360 | 56372 | 56384 | 56396 | 56407 | 56419 | 56431 | 56443 | 56455 |
| 580 | 56467 | 56478 | 56490 | 56502 | 56514 | 56526 | 56538 | 56549 | 56561 | 56573 |
| 585 | 56585 | 56597 | 56608 | 56620 | 56632 | 56644 | 56656 | 56667 | 56679 | 56691 |
| 590 | 56703 | 56714 | 56726 | 56738 | 56750 | 56761 | 56773 | 56785 | 56797 | 56808 |
| 595 | 56820 | 56832 | 56844 | 56855 | 56867 | 56879 | 56891 | 56902 | 56914 | 56926 |
| 600 | 56937 | 56949 | 56961 | 56972 | 56984 | 56996 | 57008 | 57019 | 57031 | 57043 |
| 605 | 57054 | 57066 | 57078 | 57089 | 57101 | 57113 | 57124 | 57136 | 57148 | 57159 |
| 610 | 57171 | 57183 | 57194 | 57206 | 57217 | 57229 | 57241 | 57252 | 57264 | 57276 |
| 615 | 57287 | 57299 | 57310 | 57322 | 57334 | 57345 | 57357 | 57368 | 57380 | 57392 |
| 620 | 57403 | 57415 | 57426 | 57438 | 57449 | 57461 | 57473 | 57484 | 57496 | 57507 |
| 625 | 57519 | 57530 | 57542 | 57553 | 57565 | 57576 | 57588 | 57600 | 57611 | 57623 |
| 630 | 57634 | 57646 | 57657 | 57669 | 57680 | 57692 | 57703 | 57715 | 57726 | 57738 |
| 635 | 57749 | 57761 | 57772 | 57784 | 57795 | 57807 | 57818 | 57830 | 57841 | 57852 |
| 640 | 57864 | 57875 | 57887 | 57898 | 57910 | 57921 | 57933 | 57944 | 57955 | 57967 |
| 645 | 57978 | 57990 | 58001 | 58013 | 58024 | 58035 | 58047 | 58058 | 58070 | 58081 |
| 650 | 58092 | 58104 | 58115 | 58127 | 58138 | 58149 | 58161 | 58172 | 58184 | 58195 |
| 655 | 58206 | 58218 | 58229 | 58240 | 58252 | 58263 | 58274 | 58286 | 58297 | 58309 |
| 660 | 58320 | 58331 | 58343 | 58354 | 58365 | 58377 | 58388 | 58399 | 58410 | 58422 |
| 665 | 58433 | 58444 | 58456 | 58467 | 58478 | 58490 | 58501 | 58512 | 58524 | 58535 |
| 670 | 58546 | 58557 | 58569 | 58580 | 58591 | 58602 | 58614 | 58625 | 58636 | 58647 |
| 675 | 58659 | 58670 | 58681 | 58692 | 58704 | 58715 | 58726 | 58737 | 58749 | 58760 |
| 680 | 58771 | 58782 | 58794 | 58805 | 58816 | 58827 | 58838 | 58850 | 58861 | 58872 |
| 685 | 58883 | 58894 | 58906 | 58917 | 58928 | 58939 | 58950 | 58961 | 58973 | 58984 |
| 690 | 58995 | 59006 | 59017 | 59028 | 59040 | 59051 | 59062 | 59073 | 59084 | 59095 |
| 695 | 59106 | 59118 | 59129 | 59140 | 59151 | 59162 | 59173 | 59184 | 59195 | 59207 |
| 700 | 59218 | 59229 | 59240 | 59251 | 59262 | 59273 | 59284 | 59295 | 59306 | 59318 |
| 705 | 59329 | 59340 | 59351 | 59362 | 59373 | 59384 | 59395 | 59406 | 59417 | 59428 |
| 710 | 59439 | 59450 | 59461 | 59472 | 59483 | 59494 | 59505 | 59517 | 59528 | 59539 |
| 715 | 59550 | 59561 | 59572 | 59583 | 59594 | 59605 | 59616 | 59627 | 59638 | 59649 |
| 720 | 59660 | 59671 | 59682 | 59693 | 59704 | 59715 | 59726 | 59737 | 59748 | 59759 |
| 725 | 59770 | 59780 | 59791 | 59802 | 59813 | 59824 | 59835 | 59846 | 59857 | 59868 |
| 730 | 59879 | 59890 | 59901 | 59912 | 59923 | 59934 | 59945 | 59956 | 59967 | 59978 |
| 735 | 59988 | 59999 | 60010 | 60021 | 60032 | 60043 | 60054 | 60065 | 60076 | 60086 |
| 740 | 60097 | 60108 | 60119 | 60130 | 60141 | 60152 | 60163 | 60173 | 60184 | 60195 |



TABLE IV.

A Table of Logarithms from 1 to 10,000.

| No. | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|-----|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 100 | 2.60206 | 2.60217 | 2.60228 | 2.60239 | 2.60249 | 2.60260 | 2.60271 | 2.60282 | 2.60293 | 2.60304 |
| 01  | 60314   | 60325   | 60336   | 60347   | 60358   | 60369   | 60379   | 60390   | 60401   | 60412   |
| 02  | 60423   | 60433   | 60444   | 60455   | 60466   | 60477   | 60487   | 60498   | 60509   | 60520   |
| 03  | 60530   | 60541   | 60552   | 60563   | 60574   | 60584   | 60595   | 60606   | 60617   | 60628   |
| 04  | 60638   | 60649   | 60660   | 60670   | 60681   | 60692   | 60703   | 60713   | 60724   | 60735   |
| 05  | 60746   | 60756   | 60767   | 60778   | 60788   | 60799   | 60810   | 60820   | 60831   | 60842   |
| 06  | 60853   | 60863   | 60874   | 60885   | 60895   | 60906   | 60917   | 60927   | 60938   | 60949   |
| 07  | 60959   | 60970   | 60981   | 60991   | 61002   | 61013   | 61023   | 61034   | 61045   | 61056   |
| 08  | 61066   | 61077   | 61087   | 61098   | 61109   | 61119   | 61130   | 61140   | 61151   | 61162   |
| 09  | 61172   | 61183   | 61194   | 61204   | 61215   | 61225   | 61236   | 61247   | 61257   | 61268   |
| 110 | 2.61278 | 2.61289 | 2.61300 | 2.61310 | 2.61321 | 2.61331 | 2.61342 | 2.61352 | 2.61363 | 2.61374 |
| 11  | 61384   | 61395   | 61405   | 61416   | 61426   | 61437   | 61448   | 61458   | 61469   | 61479   |
| 12  | 61490   | 61500   | 61511   | 61521   | 61532   | 61542   | 61553   | 61563   | 61574   | 61584   |
| 13  | 61595   | 61606   | 61616   | 61627   | 61637   | 61648   | 61658   | 61669   | 61679   | 61689   |
| 14  | 61700   | 61711   | 61721   | 61731   | 61742   | 61752   | 61763   | 61773   | 61784   | 61794   |
| 15  | 61805   | 61815   | 61826   | 61836   | 61847   | 61857   | 61868   | 61878   | 61888   | 61898   |
| 16  | 61909   | 61920   | 61930   | 61941   | 61951   | 61961   | 61972   | 61982   | 61993   | 62003   |
| 17  | 62014   | 62024   | 62034   | 62045   | 62055   | 62066   | 62076   | 62086   | 62097   | 62107   |
| 18  | 62118   | 62128   | 62138   | 62149   | 62159   | 62170   | 62180   | 62190   | 62201   | 62211   |
| 19  | 62221   | 62232   | 62242   | 62252   | 62263   | 62273   | 62284   | 62294   | 62304   | 62314   |
| 210 | 2.62325 | 2.62335 | 2.62346 | 2.62356 | 2.62366 | 2.62377 | 2.62387 | 2.62397 | 2.62408 | 2.62418 |
| 21  | 62428   | 62439   | 62449   | 62459   | 62469   | 62480   | 62490   | 62500   | 62511   | 62521   |
| 22  | 62531   | 62542   | 62552   | 62562   | 62572   | 62583   | 62593   | 62603   | 62613   | 62623   |
| 23  | 62634   | 62644   | 62655   | 62665   | 62675   | 62685   | 62696   | 62706   | 62716   | 62726   |
| 24  | 62737   | 62747   | 62757   | 62767   | 62778   | 62788   | 62798   | 62808   | 62818   | 62828   |
| 25  | 62839   | 62849   | 62859   | 62870   | 62880   | 62890   | 62900   | 62910   | 62921   | 62931   |
| 26  | 62941   | 62951   | 62961   | 62972   | 62982   | 62992   | 63002   | 63012   | 63022   | 63032   |
| 27  | 63043   | 63053   | 63063   | 63073   | 63083   | 63094   | 63104   | 63114   | 63124   | 63134   |
| 28  | 63144   | 63155   | 63165   | 63175   | 63185   | 63195   | 63205   | 63215   | 63225   | 63235   |
| 29  | 63246   | 63256   | 63266   | 63276   | 63286   | 63296   | 63306   | 63317   | 63327   | 63337   |
| 310 | 2.63347 | 2.63357 | 2.63367 | 2.63377 | 2.63387 | 2.63397 | 2.63407 | 2.63417 | 2.63428 | 2.63438 |
| 31  | 63448   | 63458   | 63468   | 63478   | 63488   | 63498   | 63508   | 63518   | 63528   | 63538   |
| 32  | 63548   | 63558   | 63568   | 63579   | 63589   | 63599   | 63609   | 63619   | 63629   | 63639   |
| 33  | 63649   | 63659   | 63669   | 63679   | 63689   | 63699   | 63709   | 63719   | 63729   | 63739   |
| 34  | 63749   | 63759   | 63769   | 63779   | 63789   | 63799   | 63809   | 63819   | 63829   | 63839   |
| 35  | 63849   | 63859   | 63869   | 63879   | 63889   | 63899   | 63909   | 63919   | 63929   | 63939   |
| 36  | 63949   | 63959   | 63969   | 63979   | 63988   | 63998   | 64008   | 64018   | 64028   | 64038   |
| 37  | 64048   | 64058   | 64068   | 64078   | 64088   | 64098   | 64108   | 64118   | 64128   | 64138   |
| 38  | 64147   | 64157   | 64167   | 64177   | 64187   | 64197   | 64207   | 64217   | 64227   | 64237   |
| 39  | 64246   | 64256   | 64266   | 64276   | 64286   | 64296   | 64306   | 64316   | 64326   | 64336   |
| 410 | 2.64345 | 2.64355 | 2.64365 | 2.64375 | 2.64385 | 2.64395 | 2.64404 | 2.64414 | 2.64424 | 2.64434 |
| 41  | 64444   | 64454   | 64464   | 64473   | 64483   | 64493   | 64503   | 64513   | 64523   | 64533   |
| 42  | 64542   | 64552   | 64562   | 64572   | 64582   | 64591   | 64601   | 64611   | 64621   | 64631   |
| 43  | 64640   | 64650   | 64660   | 64670   | 64680   | 64689   | 64699   | 64709   | 64719   | 64729   |
| 44  | 64738   | 64748   | 64758   | 64768   | 64777   | 64787   | 64797   | 64807   | 64816   | 64826   |
| 45  | 64836   | 64846   | 64856   | 64865   | 64875   | 64885   | 64895   | 64904   | 64914   | 64924   |
| 46  | 64933   | 64943   | 64953   | 64963   | 64972   | 64982   | 64992   | 65002   | 65011   | 65021   |
| 47  | 65031   | 65040   | 65050   | 65060   | 65070   | 65079   | 65089   | 65099   | 65108   | 65118   |
| 48  | 65128   | 65137   | 65147   | 65157   | 65167   | 65176   | 65186   | 65196   | 65205   | 65215   |
| 49  | 65225   | 65234   | 65244   | 65254   | 65263   | 65273   | 65283   | 65292   | 65302   | 65312   |
| 510 | 2.65321 | 2.65331 | 2.65341 | 2.65350 | 2.65360 | 2.65369 | 2.65379 | 2.65389 | 2.65398 | 2.65408 |
| 51  | 65418   | 65427   | 65437   | 65447   | 65456   | 65466   | 65475   | 65485   | 65495   | 65505   |
| 52  | 65514   | 65523   | 65533   | 65543   | 65552   | 65562   | 65571   | 65581   | 65591   | 65601   |
| 53  | 65610   | 65619   | 65629   | 65639   | 65648   | 65658   | 65667   | 65677   | 65686   | 65696   |
| 54  | 65706   | 65715   | 65725   | 65734   | 65744   | 65753   | 65763   | 65772   | 65782   | 65792   |
| 55  | 65801   | 65811   | 65820   | 65830   | 65839   | 65849   | 65858   | 65868   | 65877   | 65887   |
| 56  | 65896   | 65906   | 65916   | 65925   | 65935   | 65944   | 65954   | 65963   | 65973   | 65983   |
| 57  | 65992   | 66001   | 66011   | 66020   | 66030   | 66039   | 66049   | 66058   | 66068   | 66078   |
| 58  | 66087   | 66096   | 66106   | 66115   | 66124   | 66134   | 66143   | 66153   | 66162   | 66172   |
| 459 | 66181   | 66191   | 66200   | 66210   | 66219   | 66229   | 66238   | 66247   | 66257   | 66267   |

TABLE IV.

A Table of Logarithms from 1 to 10,000

|         | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9 |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---|
| 2.66276 | 2.66285 | 2.66295 | 2.66304 | 2.66314 | 2.66323 | 2.66332 | 2.66342 | 2.66351 | 2.66361 |   |
| 66370   | 66380   | 66389   | 66398   | 66408   | 66417   | 66427   | 66436   | 66445   | 66455   |   |
| 66464   | 66474   | 66483   | 66492   | 66502   | 66511   | 66521   | 66530   | 66539   | 66549   |   |
| 66558   | 66567   | 66577   | 66586   | 66596   | 66605   | 66614   | 66624   | 66633   | 66642   |   |
| 66652   | 66661   | 66671   | 66680   | 66689   | 66699   | 66708   | 66717   | 66727   | 66736   |   |
| 66745   | 66755   | 66764   | 66773   | 66783   | 66792   | 66801   | 66811   | 66820   | 66829   |   |
| 66839   | 66848   | 66857   | 66867   | 66876   | 66885   | 66894   | 66904   | 66913   | 66922   |   |
| 66932   | 66941   | 66950   | 66960   | 66969   | 66978   | 66987   | 66997   | 67006   | 67015   |   |
| 67025   | 67034   | 67043   | 67052   | 67062   | 67071   | 67080   | 67089   | 67099   | 67108   |   |
| 67117   | 67127   | 67136   | 67145   | 67154   | 67164   | 67173   | 67182   | 67191   | 67201   |   |
| 2.67210 | 2.67219 | 2.67228 | 2.67237 | 2.67247 | 2.67256 | 2.67265 | 2.67274 | 2.67284 | 2.67293 |   |
| 67302   | 67311   | 67321   | 67330   | 67339   | 67348   | 67357   | 67367   | 67376   | 67385   |   |
| 67394   | 67403   | 67413   | 67422   | 67431   | 67440   | 67449   | 67459   | 67468   | 67477   |   |
| 67486   | 67495   | 67504   | 67514   | 67523   | 67532   | 67541   | 67550   | 67560   | 67569   |   |
| 67578   | 67587   | 67596   | 67605   | 67614   | 67624   | 67633   | 67642   | 67651   | 67660   |   |
| 67669   | 67678   | 67688   | 67697   | 67706   | 67715   | 67724   | 67733   | 67742   | 67752   |   |
| 67761   | 67770   | 67779   | 67788   | 67797   | 67806   | 67815   | 67825   | 67834   | 67843   |   |
| 67852   | 67861   | 67870   | 67879   | 67888   | 67897   | 67906   | 67916   | 67925   | 67934   |   |
| 67943   | 67952   | 67961   | 67970   | 67979   | 67988   | 67997   | 68006   | 68015   | 68024   |   |
| 68034   | 68043   | 68052   | 68061   | 68070   | 68079   | 68088   | 68097   | 68106   | 68115   |   |
| 2.68124 | 2.68133 | 2.68142 | 2.68151 | 2.68160 | 2.68169 | 2.68178 | 2.68187 | 2.68196 | 2.68205 |   |
| 68215   | 68224   | 68233   | 68242   | 68251   | 68260   | 68269   | 68278   | 68287   | 68296   |   |
| 68305   | 68314   | 68323   | 68332   | 68341   | 68350   | 68359   | 68368   | 68377   | 68386   |   |
| 68395   | 68404   | 68413   | 68422   | 68431   | 68440   | 68449   | 68458   | 68467   | 68476   |   |
| 68485   | 68494   | 68502   | 68511   | 68520   | 68529   | 68538   | 68547   | 68556   | 68565   |   |
| 68574   | 68583   | 68592   | 68601   | 68610   | 68619   | 68628   | 68637   | 68646   | 68655   |   |
| 68664   | 68673   | 68681   | 68690   | 68699   | 68708   | 68717   | 68726   | 68735   | 68744   |   |
| 68753   | 68762   | 68771   | 68780   | 68789   | 68797   | 68806   | 68815   | 68824   | 68833   |   |
| 68842   | 68851   | 68860   | 68869   | 68878   | 68886   | 68895   | 68904   | 68913   | 68922   |   |
| 68931   | 68940   | 68949   | 68958   | 68966   | 68975   | 68984   | 68993   | 69002   | 69011   |   |
| 2.69020 | 2.69028 | 2.69037 | 2.69046 | 2.69055 | 2.69064 | 2.69073 | 2.69082 | 2.69090 | 2.69099 |   |
| 69108   | 69117   | 69126   | 69135   | 69144   | 69152   | 69161   | 69170   | 69179   | 69188   |   |
| 69197   | 69205   | 69214   | 69223   | 69232   | 69241   | 69249   | 69258   | 69267   | 69276   |   |
| 69285   | 69293   | 69302   | 69311   | 69320   | 69329   | 69338   | 69346   | 69355   | 69364   |   |
| 69373   | 69381   | 69390   | 69399   | 69408   | 69417   | 69425   | 69434   | 69443   | 69452   |   |
| 69461   | 69469   | 69478   | 69487   | 69496   | 69504   | 69513   | 69522   | 69531   | 69539   |   |
| 69548   | 69557   | 69566   | 69574   | 69583   | 69592   | 69601   | 69609   | 69618   | 69627   |   |
| 69636   | 69644   | 69653   | 69662   | 69671   | 69679   | 69688   | 69697   | 69705   | 69714   |   |
| 69723   | 69732   | 69740   | 69749   | 69758   | 69767   | 69775   | 69784   | 69793   | 69801   |   |
| 69810   | 69819   | 69827   | 69836   | 69845   | 69854   | 69862   | 69871   | 69880   | 69888   |   |
| 2.69897 | 2.69906 | 2.69914 | 2.69923 | 2.69932 | 2.69940 | 2.69949 | 2.69958 | 2.69966 | 2.69975 |   |
| 69984   | 69992   | 70001   | 70010   | 70018   | 70027   | 70036   | 70044   | 70053   | 70062   |   |
| 70070   | 70079   | 70088   | 70096   | 70105   | 70114   | 70122   | 70131   | 70140   | 70148   |   |
| 70157   | 70165   | 70174   | 70183   | 70191   | 70200   | 70209   | 70217   | 70226   | 70234   |   |
| 70243   | 70252   | 70260   | 70269   | 70278   | 70286   | 70295   | 70303   | 70312   | 70321   |   |
| 70329   | 70338   | 70346   | 70355   | 70364   | 70372   | 70381   | 70389   | 70398   | 70406   |   |
| 70415   | 70424   | 70432   | 70441   | 70449   | 70458   | 70467   | 70475   | 70484   | 70492   |   |
| 70501   | 70509   | 70518   | 70526   | 70535   | 70544   | 70552   | 70561   | 70569   | 70578   |   |
| 70586   | 70595   | 70603   | 70612   | 70621   | 70629   | 70638   | 70646   | 70655   | 70663   |   |
| 70672   | 70680   | 70689   | 70697   | 70706   | 70714   | 70723   | 70731   | 70740   | 70748   |   |
| 2.70757 | 2.70766 | 2.70774 | 2.70783 | 2.70791 | 2.70800 | 2.70808 | 2.70817 | 2.70825 | 2.70834 |   |
| 70842   | 70851   | 70859   | 70868   | 70876   | 70885   | 70893   | 70902   | 70910   | 70919   |   |
| 70927   | 70935   | 70944   | 70952   | 70961   | 70969   | 70978   | 70986   | 70995   | 71003   |   |
| 71012   | 71020   | 71029   | 71037   | 71046   | 71054   | 71062   | 71071   | 71079   | 71088   |   |
| 71096   | 71105   | 71113   | 71122   | 71130   | 71139   | 71147   | 71155   | 71164   | 71172   |   |
| 71181   | 71189   | 71198   | 71206   | 71214   | 71223   | 71231   | 71240   | 71248   | 71257   |   |
| 71265   | 71273   | 71282   | 71290   | 71299   | 71307   | 71315   | 71324   | 71332   | 71341   |   |
| 71349   | 71357   | 71366   | 71374   | 71383   | 71391   | 71399   | 71408   | 71416   | 71425   |   |
| 71433   | 71441   | 71450   | 71458   | 71466   | 71475   | 71483   | 71492   | 71500   | 71508   |   |
| 71517   | 71525   | 71533   | 71542   | 71550   | 71559   | 71567   | 71575   | 71584   | 71592   |   |

TABLE IV.

A Table of Logarithms from 1 to 10,000.

| No  | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|-----|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 520 | 2.71600 | 2.71609 | 2.71617 | 2.71625 | 2.71634 | 2.71642 | 2.71650 | 2.71659 | 2.71667 | 2.71675 |
| 21  | 71684   | 71692   | 71700   | 71709   | 71717   | 71725   | 71734   | 71742   | 71750   | 71758   |
| 22  | 71767   | 71775   | 71784   | 71792   | 71800   | 71809   | 71817   | 71825   | 71834   | 71842   |
| 23  | 71850   | 71858   | 71867   | 71875   | 71883   | 71892   | 71900   | 71908   | 71917   | 71925   |
| 24  | 71933   | 71941   | 71950   | 71958   | 71966   | 71975   | 71983   | 71991   | 71999   | 72008   |
| 25  | 72016   | 72024   | 72032   | 72041   | 72049   | 72057   | 72066   | 72074   | 72082   | 72090   |
| 26  | 72099   | 72107   | 72115   | 72123   | 72132   | 72140   | 72148   | 72156   | 72165   | 72173   |
| 27  | 72181   | 72189   | 72198   | 72206   | 72214   | 72222   | 72230   | 72239   | 72247   | 72255   |
| 28  | 72263   | 72272   | 72280   | 72288   | 72296   | 72304   | 72313   | 72321   | 72329   | 72337   |
| 29  | 72346   | 72354   | 72362   | 72370   | 72378   | 72387   | 72395   | 72403   | 72411   | 72419   |
| 530 | 2.72428 | 2.72436 | 2.72444 | 2.72452 | 2.72460 | 2.72469 | 2.72477 | 2.72485 | 2.72493 | 2.72501 |
| 31  | 72509   | 72518   | 72526   | 72534   | 72542   | 72550   | 72558   | 72567   | 72575   | 72583   |
| 32  | 72591   | 72599   | 72607   | 72616   | 72624   | 72632   | 72640   | 72648   | 72656   | 72664   |
| 33  | 72673   | 72681   | 72689   | 72697   | 72705   | 72713   | 72722   | 72730   | 72738   | 72746   |
| 34  | 72754   | 72762   | 72770   | 72779   | 72787   | 72795   | 72803   | 72811   | 72819   | 72827   |
| 35  | 72835   | 72843   | 72852   | 72860   | 72868   | 72876   | 72884   | 72892   | 72900   | 72908   |
| 36  | 72916   | 72925   | 72933   | 72941   | 72949   | 72957   | 72965   | 72973   | 72981   | 72989   |
| 37  | 72997   | 73006   | 73014   | 73022   | 73030   | 73038   | 73046   | 73054   | 73062   | 73070   |
| 38  | 73078   | 73086   | 73094   | 73102   | 73111   | 73119   | 73127   | 73135   | 73143   | 73151   |
| 39  | 73159   | 73167   | 73175   | 73183   | 73191   | 73199   | 73207   | 73215   | 73223   | 73231   |
| 540 | 2.73239 | 2.73247 | 2.73255 | 2.73263 | 2.73272 | 2.73280 | 2.73288 | 2.73296 | 2.73304 | 2.73312 |
| 41  | 73320   | 73328   | 73336   | 73344   | 73352   | 73360   | 73368   | 73376   | 73384   | 73392   |
| 42  | 73400   | 73408   | 73416   | 73424   | 73432   | 73440   | 73448   | 73456   | 73464   | 73472   |
| 43  | 73480   | 73488   | 73496   | 73504   | 73512   | 73520   | 73528   | 73536   | 73544   | 73552   |
| 44  | 73560   | 73568   | 73576   | 73584   | 73592   | 73600   | 73608   | 73616   | 73624   | 73632   |
| 45  | 73640   | 73648   | 73656   | 73664   | 73672   | 73680   | 73688   | 73696   | 73704   | 73712   |
| 46  | 73719   | 73727   | 73735   | 73743   | 73751   | 73759   | 73767   | 73775   | 73783   | 73791   |
| 47  | 73799   | 73807   | 73815   | 73823   | 73830   | 73838   | 73846   | 73854   | 73862   | 73870   |
| 48  | 73878   | 73886   | 73894   | 73902   | 73910   | 73918   | 73926   | 73933   | 73941   | 73949   |
| 49  | 73957   | 73965   | 73973   | 73981   | 73989   | 73997   | 74005   | 74013   | 74020   | 74028   |
| 550 | 2.74036 | 2.74044 | 2.74052 | 2.74060 | 2.74068 | 2.74076 | 2.74084 | 2.74092 | 2.74099 | 2.74107 |
| 51  | 74115   | 74123   | 74131   | 74139   | 74147   | 74155   | 74162   | 74170   | 74178   | 74186   |
| 52  | 74194   | 74202   | 74210   | 74218   | 74225   | 74233   | 74241   | 74249   | 74257   | 74265   |
| 53  | 74273   | 74280   | 74288   | 74296   | 74304   | 74312   | 74320   | 74327   | 74335   | 74343   |
| 54  | 74351   | 74359   | 74367   | 74374   | 74382   | 74390   | 74398   | 74406   | 74414   | 74422   |
| 55  | 74429   | 74437   | 74445   | 74453   | 74461   | 74468   | 74476   | 74484   | 74492   | 74500   |
| 56  | 74507   | 74515   | 74523   | 74531   | 74539   | 74547   | 74554   | 74562   | 74570   | 74578   |
| 57  | 74586   | 74593   | 74601   | 74609   | 74617   | 74624   | 74632   | 74640   | 74648   | 74656   |
| 58  | 74663   | 74671   | 74679   | 74687   | 74695   | 74702   | 74710   | 74718   | 74726   | 74734   |
| 59  | 74741   | 74749   | 74757   | 74764   | 74772   | 74780   | 74788   | 74796   | 74803   | 74811   |
| 560 | 2.74819 | 2.74827 | 2.74834 | 2.74842 | 2.74850 | 2.74858 | 2.74865 | 2.74873 | 2.74881 | 2.74889 |
| 61  | 74896   | 74904   | 74912   | 74920   | 74927   | 74935   | 74943   | 74950   | 74958   | 74966   |
| 62  | 74974   | 74982   | 74989   | 74997   | 75005   | 75012   | 75020   | 75028   | 75035   | 75043   |
| 63  | 75051   | 75059   | 75066   | 75074   | 75082   | 75089   | 75097   | 75105   | 75113   | 75121   |
| 64  | 75128   | 75136   | 75143   | 75151   | 75159   | 75166   | 75174   | 75182   | 75189   | 75197   |
| 65  | 75205   | 75213   | 75220   | 75228   | 75236   | 75243   | 75251   | 75259   | 75266   | 75274   |
| 66  | 75282   | 75289   | 75297   | 75305   | 75312   | 75320   | 75328   | 75335   | 75343   | 75351   |
| 67  | 75358   | 75366   | 75374   | 75381   | 75389   | 75397   | 75404   | 75412   | 75420   | 75428   |
| 68  | 75435   | 75442   | 75450   | 75458   | 75465   | 75473   | 75481   | 75488   | 75496   | 75504   |
| 69  | 75511   | 75519   | 75526   | 75534   | 75542   | 75549   | 75557   | 75565   | 75572   | 75580   |
| 570 | 2.75587 | 2.75595 | 2.75603 | 2.75610 | 2.75618 | 2.75626 | 2.75633 | 2.75641 | 2.75648 | 2.75656 |
| 71  | 75664   | 75671   | 75679   | 75686   | 75694   | 75702   | 75709   | 75717   | 75724   | 75732   |
| 72  | 75740   | 75747   | 75755   | 75762   | 75770   | 75778   | 75785   | 75793   | 75800   | 75808   |
| 73  | 75815   | 75823   | 75831   | 75838   | 75846   | 75853   | 75861   | 75868   | 75876   | 75884   |
| 74  | 75891   | 75899   | 75906   | 75914   | 75921   | 75929   | 75937   | 75944   | 75952   | 75959   |
| 75  | 75967   | 75974   | 75982   | 75989   | 75997   | 76005   | 76012   | 76020   | 76027   | 76035   |
| 76  | 76042   | 76050   | 76057   | 76065   | 76072   | 76080   | 76087   | 76095   | 76103   | 76111   |
| 77  | 76118   | 76125   | 76133   | 76140   | 76148   | 76155   | 76163   | 76170   | 76178   | 76186   |
| 78  | 76193   | 76200   | 76208   | 76215   | 76223   | 76230   | 76238   | 76245   | 76253   | 76261   |
| 579 | 76268   | 76275   | 76283   | 76290   | 76298   | 76305   | 76313   | 76320   | 76328   | 76336   |



TABLE IV.

A Table of Logarithms from 1 to 10,000.

| No | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|----|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 80 | 2.76343 | 2.76350 | 2.76358 | 2.76365 | 2.76373 | 2.76380 | 2.76388 | 2.76395 | 2.76403 | 2.76410 |
| 81 | 76418   | 76425   | 76433   | 76440   | 76448   | 76455   | 76462   | 76470   | 76477   | 76485   |
| 82 | 76492   | 76500   | 76507   | 76515   | 76522   | 76530   | 76537   | 76545   | 76552   | 76559   |
| 83 | 76567   | 76574   | 76582   | 76589   | 76597   | 76604   | 76612   | 76619   | 76626   | 76634   |
| 84 | 76641   | 76649   | 76656   | 76664   | 76671   | 76678   | 76686   | 76693   | 76701   | 76708   |
| 85 | 76716   | 76723   | 76730   | 76738   | 76745   | 76753   | 76760   | 76768   | 76775   | 76782   |
| 86 | 76790   | 76797   | 76805   | 76812   | 76819   | 76827   | 76834   | 76842   | 76849   | 76856   |
| 87 | 76864   | 76871   | 76879   | 76886   | 76893   | 76901   | 76908   | 76916   | 76923   | 76930   |
| 88 | 76938   | 76945   | 76953   | 76960   | 76967   | 76975   | 76982   | 76989   | 76997   | 77004   |
| 89 | 77012   | 77019   | 77026   | 77034   | 77041   | 77048   | 77056   | 77063   | 77070   | 77078   |
| 90 | 2.77085 | 2.77093 | 2.77100 | 2.77107 | 2.77115 | 2.77122 | 2.77129 | 2.77137 | 2.77144 | 2.77151 |
| 91 | 77159   | 77166   | 77173   | 77181   | 77188   | 77195   | 77203   | 77210   | 77217   | 77225   |
| 92 | 77232   | 77240   | 77247   | 77254   | 77262   | 77269   | 77276   | 77283   | 77291   | 77298   |
| 93 | 77305   | 77313   | 77320   | 77327   | 77335   | 77342   | 77349   | 77357   | 77364   | 77371   |
| 94 | 77379   | 77386   | 77393   | 77401   | 77408   | 77415   | 77422   | 77430   | 77437   | 77444   |
| 95 | 77452   | 77459   | 77466   | 77474   | 77481   | 77488   | 77495   | 77503   | 77510   | 77517   |
| 96 | 77525   | 77532   | 77539   | 77546   | 77554   | 77561   | 77568   | 77576   | 77583   | 77590   |
| 97 | 77597   | 77605   | 77612   | 77619   | 77627   | 77634   | 77641   | 77648   | 77656   | 77663   |
| 98 | 77670   | 77677   | 77685   | 77692   | 77699   | 77706   | 77714   | 77721   | 77728   | 77735   |
| 99 | 77743   | 77750   | 77757   | 77764   | 77772   | 77779   | 77786   | 77793   | 77801   | 77808   |
| 00 | 2.77815 | 2.77822 | 2.77830 | 2.77837 | 2.77844 | 2.77851 | 2.77859 | 2.77866 | 2.77873 | 2.77880 |
| 01 | 77887   | 77895   | 77902   | 77909   | 77916   | 77924   | 77931   | 77938   | 77945   | 77952   |
| 02 | 77960   | 77967   | 77974   | 77981   | 77988   | 77996   | 78003   | 78010   | 78017   | 78025   |
| 03 | 78032   | 78039   | 78046   | 78053   | 78061   | 78068   | 78075   | 78082   | 78089   | 78097   |
| 04 | 78104   | 78111   | 78118   | 78125   | 78132   | 78140   | 78147   | 78154   | 78161   | 78168   |
| 05 | 78176   | 78183   | 78190   | 78197   | 78204   | 78211   | 78219   | 78226   | 78233   | 78240   |
| 06 | 78247   | 78254   | 78262   | 78269   | 78276   | 78283   | 78290   | 78297   | 78305   | 78312   |
| 07 | 78319   | 78326   | 78333   | 78340   | 78347   | 78355   | 78362   | 78369   | 78376   | 78383   |
| 08 | 78390   | 78398   | 78405   | 78412   | 78419   | 78426   | 78433   | 78440   | 78447   | 78455   |
| 09 | 78462   | 78469   | 78476   | 78483   | 78490   | 78497   | 78504   | 78512   | 78519   | 78526   |
| 10 | 2.78533 | 2.78540 | 2.78547 | 2.78554 | 2.78561 | 2.78569 | 2.78576 | 2.78583 | 2.78590 | 2.78597 |
| 11 | 78604   | 78611   | 78618   | 78625   | 78633   | 78640   | 78647   | 78654   | 78661   | 78668   |
| 12 | 78675   | 78682   | 78689   | 78696   | 78704   | 78711   | 78718   | 78725   | 78732   | 78739   |
| 13 | 78746   | 78753   | 78760   | 78767   | 78774   | 78781   | 78789   | 78796   | 78803   | 78810   |
| 14 | 78817   | 78824   | 78831   | 78838   | 78845   | 78852   | 78859   | 78866   | 78873   | 78880   |
| 15 | 78888   | 78895   | 78902   | 78909   | 78916   | 78923   | 78930   | 78937   | 78944   | 78951   |
| 16 | 78958   | 78965   | 78972   | 78979   | 78986   | 78993   | 79000   | 79007   | 79014   | 79021   |
| 17 | 79029   | 79036   | 79043   | 79050   | 79057   | 79064   | 79071   | 79078   | 79085   | 79092   |
| 18 | 79099   | 79106   | 79113   | 79120   | 79127   | 79134   | 79141   | 79148   | 79155   | 79162   |
| 19 | 79169   | 79176   | 79183   | 79190   | 79197   | 79204   | 79211   | 79218   | 79225   | 79232   |
| 20 | 2.79239 | 2.79246 | 2.79253 | 2.79260 | 2.79267 | 2.79274 | 2.79281 | 2.79288 | 2.79295 | 2.79302 |
| 21 | 79309   | 79316   | 79323   | 79330   | 79337   | 79344   | 79351   | 79358   | 79365   | 79372   |
| 22 | 79379   | 79386   | 79393   | 79400   | 79407   | 79414   | 79421   | 79428   | 79435   | 79442   |
| 23 | 79449   | 79456   | 79463   | 79470   | 79477   | 79484   | 79491   | 79498   | 79505   | 79511   |
| 24 | 79518   | 79525   | 79532   | 79539   | 79546   | 79553   | 79560   | 79567   | 79574   | 79581   |
| 25 | 79588   | 79595   | 79602   | 79609   | 79616   | 79623   | 79630   | 79637   | 79644   | 79650   |
| 26 | 79657   | 79664   | 79671   | 79678   | 79685   | 79692   | 79699   | 79706   | 79713   | 79720   |
| 27 | 79727   | 79734   | 79741   | 79748   | 79754   | 79761   | 79768   | 79775   | 79782   | 79789   |
| 28 | 79796   | 79803   | 79810   | 79817   | 79824   | 79831   | 79837   | 79844   | 79851   | 79858   |
| 29 | 79865   | 79872   | 79879   | 79886   | 79893   | 79900   | 79906   | 79913   | 79920   | 79927   |
| 30 | 2.79934 | 2.79941 | 2.79948 | 2.79955 | 2.79962 | 2.79969 | 2.79975 | 2.79982 | 2.79989 | 2.79996 |
| 31 | 80003   | 80010   | 80017   | 80024   | 80031   | 80037   | 80044   | 80051   | 80058   | 80065   |
| 32 | 80072   | 80079   | 80085   | 80092   | 80099   | 80106   | 80113   | 80120   | 80127   | 80134   |
| 33 | 80140   | 80147   | 80154   | 80161   | 80168   | 80175   | 80182   | 80188   | 80195   | 80202   |
| 34 | 80209   | 80216   | 80223   | 80229   | 80236   | 80243   | 80250   | 80257   | 80264   | 80271   |
| 35 | 80277   | 80284   | 80291   | 80298   | 80305   | 80312   | 80318   | 80325   | 80332   | 80339   |
| 36 | 80346   | 80353   | 80359   | 80366   | 80373   | 80380   | 80387   | 80393   | 80400   | 80407   |
| 37 | 80414   | 80421   | 80428   | 80434   | 80441   | 80448   | 80455   | 80462   | 80468   | 80475   |
| 38 | 80482   | 80489   | 80496   | 80502   | 80509   | 80516   | 80523   | 80530   | 80536   | 80543   |
| 39 | 80550   | 80557   | 80564   | 80570   | 80577   | 80584   | 80591   | 80598   | 80604   | 80611   |

TABLE IV.

A Table of Logarithms from 1 to 10,000.

| No  | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|-----|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 640 | 2.80618 | 2.80625 | 2.80632 | 2.80638 | 2.80645 | 2.80652 | 2.80659 | 2.80665 | 2.80672 | 2.80679 |
| 41  | 80686   | 80693   | 80699   | 80706   | 80713   | 80720   | 80726   | 80733   | 80740   | 80747   |
| 42  | 80754   | 80760   | 80767   | 80774   | 80781   | 80787   | 80794   | 80801   | 80808   | 80814   |
| 43  | 80821   | 80828   | 80835   | 80841   | 80848   | 80855   | 80862   | 80868   | 80875   | 80882   |
| 44  | 80889   | 80895   | 80902   | 80909   | 80916   | 80922   | 80929   | 80936   | 80943   | 80949   |
| 45  | 80956   | 80963   | 80969   | 80976   | 80983   | 80990   | 80996   | 81003   | 81010   | 81017   |
| 46  | 81023   | 81030   | 81037   | 81043   | 81050   | 81057   | 81064   | 81070   | 81077   | 81084   |
| 47  | 81090   | 81097   | 81104   | 81111   | 81117   | 81124   | 81131   | 81137   | 81144   | 81151   |
| 48  | 81158   | 81164   | 81171   | 81178   | 81184   | 81191   | 81198   | 81204   | 81211   | 81218   |
| 49  | 81224   | 81231   | 81238   | 81245   | 81251   | 81258   | 81265   | 81271   | 81278   | 81285   |
| 650 | 2.81291 | 2.81298 | 2.81305 | 2.81311 | 2.81318 | 2.81325 | 2.81331 | 2.81338 | 2.81345 | 2.81351 |
| 51  | 81358   | 81365   | 81371   | 81378   | 81385   | 81391   | 81398   | 81405   | 81411   | 81418   |
| 52  | 81425   | 81431   | 81438   | 81445   | 81451   | 81458   | 81465   | 81471   | 81478   | 81485   |
| 53  | 81491   | 81498   | 81505   | 81511   | 81518   | 81525   | 81531   | 81538   | 81544   | 81551   |
| 54  | 81558   | 81564   | 81571   | 81578   | 81584   | 81591   | 81598   | 81604   | 81611   | 81617   |
| 55  | 81624   | 81631   | 81637   | 81644   | 81651   | 81657   | 81664   | 81671   | 81677   | 81684   |
| 56  | 81690   | 81697   | 81704   | 81710   | 81717   | 81723   | 81730   | 81737   | 81743   | 81750   |
| 57  | 81757   | 81763   | 81770   | 81776   | 81783   | 81790   | 81796   | 81803   | 81809   | 81816   |
| 58  | 81823   | 81829   | 81836   | 81842   | 81849   | 81856   | 81862   | 81869   | 81875   | 81882   |
| 59  | 81889   | 81895   | 81902   | 81908   | 81915   | 81921   | 81928   | 81935   | 81941   | 81948   |
| 660 | 2.81954 | 2.81961 | 2.81968 | 2.81974 | 2.81981 | 2.81987 | 2.81994 | 2.82000 | 2.82007 | 2.82014 |
| 61  | 82020   | 82027   | 82033   | 82040   | 82046   | 82053   | 82060   | 82066   | 82073   | 82079   |
| 62  | 82086   | 82092   | 82099   | 82105   | 82112   | 82119   | 82125   | 82132   | 82138   | 82145   |
| 63  | 82151   | 82158   | 82164   | 82171   | 82178   | 82184   | 82191   | 82197   | 82204   | 82210   |
| 64  | 82217   | 82223   | 82230   | 82236   | 82243   | 82249   | 82256   | 82263   | 82269   | 82276   |
| 65  | 82282   | 82289   | 82295   | 82302   | 82308   | 82315   | 82321   | 82328   | 82334   | 82341   |
| 66  | 82347   | 82354   | 82360   | 82367   | 82373   | 82380   | 82387   | 82393   | 82400   | 82406   |
| 67  | 82413   | 82419   | 82426   | 82432   | 82439   | 82445   | 82452   | 82458   | 82465   | 82471   |
| 68  | 82478   | 82484   | 82491   | 82497   | 82504   | 82510   | 82517   | 82523   | 82530   | 82536   |
| 69  | 82543   | 82549   | 82556   | 82562   | 82569   | 82575   | 82582   | 82588   | 82595   | 82601   |
| 670 | 2.82607 | 2.82614 | 2.82620 | 2.82627 | 2.82633 | 2.82640 | 2.82646 | 2.82653 | 2.82659 | 2.82666 |
| 71  | 82672   | 82679   | 82685   | 82692   | 82698   | 82705   | 82711   | 82718   | 82724   | 82730   |
| 72  | 82737   | 82743   | 82750   | 82756   | 82763   | 82769   | 82776   | 82782   | 82789   | 82795   |
| 73  | 82802   | 82808   | 82814   | 82821   | 82827   | 82834   | 82840   | 82847   | 82853   | 82860   |
| 74  | 82866   | 82872   | 82879   | 82885   | 82892   | 82898   | 82905   | 82911   | 82918   | 82924   |
| 75  | 82930   | 82937   | 82943   | 82950   | 82956   | 82963   | 82969   | 82975   | 82982   | 82988   |
| 76  | 82995   | 83001   | 83008   | 83014   | 83020   | 83027   | 83033   | 83040   | 83046   | 83052   |
| 77  | 83059   | 83065   | 83072   | 83078   | 83085   | 83091   | 83097   | 83104   | 83110   | 83117   |
| 78  | 83123   | 83129   | 83136   | 83142   | 83149   | 83155   | 83161   | 83168   | 83174   | 83181   |
| 79  | 83187   | 83193   | 83200   | 83206   | 83213   | 83219   | 83225   | 83232   | 83238   | 83245   |
| 680 | 2.83251 | 2.83257 | 2.83264 | 2.83270 | 2.83276 | 2.83283 | 2.83289 | 2.83296 | 2.83302 | 2.83308 |
| 81  | 83315   | 83321   | 83327   | 83334   | 83340   | 83347   | 83353   | 83359   | 83366   | 83372   |
| 82  | 83378   | 83385   | 83391   | 83398   | 83404   | 83410   | 83417   | 83423   | 83429   | 83436   |
| 83  | 83442   | 83448   | 83455   | 83461   | 83467   | 83474   | 83480   | 83487   | 83493   | 83499   |
| 84  | 83506   | 83512   | 83518   | 83525   | 83531   | 83537   | 83544   | 83550   | 83556   | 83563   |
| 85  | 83569   | 83575   | 83582   | 83588   | 83594   | 83601   | 83607   | 83613   | 83620   | 83626   |
| 86  | 83632   | 83639   | 83645   | 83651   | 83658   | 83664   | 83670   | 83677   | 83683   | 83689   |
| 87  | 83696   | 83702   | 83708   | 83715   | 83721   | 83727   | 83734   | 83740   | 83746   | 83753   |
| 88  | 83759   | 83765   | 83771   | 83778   | 83784   | 83790   | 83797   | 83803   | 83809   | 83816   |
| 89  | 83822   | 83828   | 83835   | 83841   | 83847   | 83853   | 83860   | 83866   | 83872   | 83879   |
| 690 | 2.83885 | 2.83891 | 2.83897 | 2.83904 | 2.83910 | 2.83916 | 2.83923 | 2.83929 | 2.83935 | 2.83942 |
| 91  | 83948   | 83954   | 83960   | 83967   | 83973   | 83979   | 83985   | 83992   | 83998   | 84004   |
| 92  | 84011   | 84017   | 84023   | 84029   | 84036   | 84042   | 84048   | 84055   | 84061   | 84067   |
| 93  | 84073   | 84080   | 84086   | 84092   | 84098   | 84105   | 84111   | 84117   | 84123   | 84129   |
| 94  | 84136   | 84142   | 84148   | 84155   | 84161   | 84167   | 84173   | 84180   | 84186   | 84192   |
| 95  | 84198   | 84205   | 84211   | 84217   | 84223   | 84230   | 84236   | 84242   | 84248   | 84255   |
| 96  | 84261   | 84267   | 84273   | 84280   | 84286   | 84292   | 84298   | 84305   | 84311   | 84317   |
| 97  | 84323   | 84330   | 84336   | 84342   | 84348   | 84354   | 84361   | 84367   | 84373   | 84379   |
| 98  | 84386   | 84392   | 84398   | 84404   | 84410   | 84417   | 84423   | 84429   | 84435   | 84442   |
| 99  | 84448   | 84454   | 84460   | 84466   | 84473   | 84479   | 84485   | 84491   | 84497   | 84504   |



TABLE IV.

A Table of Logarithms from 1 to 10,000.

| N <sup>o</sup> | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|----------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 700            | 2.84510 | 2.84516 | 2.84522 | 2.84528 | 2.84535 | 2.84541 | 2.84547 | 2.84553 | 2.84559 | 2.84566 |
| 01             | 84572   | 84578   | 84584   | 84590   | 84597   | 84603   | 84609   | 84615   | 84621   | 84628   |
| 02             | 84634   | 84640   | 84646   | 84652   | 84658   | 84665   | 84671   | 84677   | 84683   | 84689   |
| 03             | 84696   | 84702   | 84708   | 84714   | 84720   | 84726   | 84733   | 84739   | 84745   | 84751   |
| 04             | 84757   | 84763   | 84770   | 84776   | 84782   | 84788   | 84794   | 84800   | 84807   | 84813   |
| 05             | 84819   | 84825   | 84831   | 84837   | 84844   | 84850   | 84856   | 84862   | 84868   | 84874   |
| 06             | 84880   | 84887   | 84893   | 84899   | 84905   | 84911   | 84917   | 84924   | 84930   | 84936   |
| 07             | 84942   | 84948   | 84954   | 84960   | 84967   | 84973   | 84979   | 84985   | 84991   | 84997   |
| 08             | 85003   | 85009   | 85016   | 85022   | 85028   | 85034   | 85040   | 85046   | 85052   | 85058   |
| 09             | 85065   | 85071   | 85077   | 85083   | 85089   | 85095   | 85101   | 85107   | 85114   | 85120   |
| 710            | 2.85126 | 2.85132 | 2.85138 | 2.85144 | 2.85150 | 2.85156 | 2.85163 | 2.85169 | 2.85175 | 2.85181 |
| 11             | 85187   | 85193   | 85199   | 85205   | 85211   | 85217   | 85224   | 85230   | 85236   | 85242   |
| 12             | 85248   | 85254   | 85260   | 85266   | 85272   | 85278   | 85285   | 85291   | 85297   | 85303   |
| 13             | 85309   | 85315   | 85321   | 85327   | 85333   | 85339   | 85345   | 85352   | 85358   | 85364   |
| 14             | 85370   | 85376   | 85382   | 85388   | 85394   | 85400   | 85406   | 85412   | 85418   | 85425   |
| 15             | 85431   | 85437   | 85443   | 85449   | 85455   | 85461   | 85467   | 85473   | 85479   | 85485   |
| 16             | 85491   | 85497   | 85503   | 85509   | 85516   | 85522   | 85528   | 85534   | 85540   | 85546   |
| 17             | 85552   | 85558   | 85564   | 85570   | 85576   | 85582   | 85588   | 85594   | 85600   | 85606   |
| 18             | 85612   | 85618   | 85625   | 85631   | 85637   | 85643   | 85649   | 85655   | 85661   | 85667   |
| 19             | 85673   | 85679   | 85685   | 85691   | 85697   | 85703   | 85709   | 85715   | 85721   | 85727   |
| 720            | 2.85733 | 2.85739 | 2.85745 | 2.85751 | 2.85757 | 2.85763 | 2.85769 | 2.85775 | 2.85781 | 2.85788 |
| 21             | 85794   | 85800   | 85806   | 85812   | 85818   | 85824   | 85830   | 85836   | 85842   | 85848   |
| 22             | 85853   | 85860   | 85866   | 85872   | 85878   | 85884   | 85890   | 85896   | 85902   | 85908   |
| 23             | 85914   | 85920   | 85926   | 85932   | 85938   | 85944   | 85950   | 85956   | 85962   | 85968   |
| 24             | 85974   | 85980   | 85986   | 85992   | 85998   | 86004   | 86010   | 86016   | 86022   | 86028   |
| 25             | 86034   | 86040   | 86046   | 86052   | 86058   | 86064   | 86070   | 86076   | 86082   | 86088   |
| 26             | 86094   | 86100   | 86106   | 86112   | 86118   | 86124   | 86130   | 86136   | 86142   | 86147   |
| 27             | 86153   | 86159   | 86165   | 86171   | 86177   | 86183   | 86189   | 86195   | 86201   | 86207   |
| 28             | 86213   | 86219   | 86225   | 86231   | 86237   | 86243   | 86249   | 86255   | 86261   | 86267   |
| 29             | 86273   | 86279   | 86285   | 86291   | 86297   | 86303   | 86308   | 86314   | 86320   | 86326   |
| 730            | 2.86332 | 2.86338 | 2.86344 | 2.86350 | 2.86356 | 2.86362 | 2.86368 | 2.86374 | 2.86380 | 2.86386 |
| 31             | 86392   | 86398   | 86404   | 86410   | 86415   | 86421   | 86427   | 86433   | 86439   | 86445   |
| 32             | 86451   | 86457   | 86463   | 86469   | 86475   | 86481   | 86487   | 86493   | 86499   | 86504   |
| 33             | 86510   | 86516   | 86522   | 86528   | 86534   | 86540   | 86546   | 86552   | 86558   | 86564   |
| 34             | 86570   | 86576   | 86581   | 86587   | 86593   | 86599   | 86605   | 86611   | 86617   | 86623   |
| 35             | 86629   | 86635   | 86641   | 86646   | 86652   | 86658   | 86664   | 86670   | 86676   | 86682   |
| 36             | 86688   | 86694   | 86700   | 86705   | 86711   | 86717   | 86723   | 86729   | 86735   | 86741   |
| 37             | 86747   | 86753   | 86759   | 86764   | 86770   | 86776   | 86782   | 86788   | 86794   | 86800   |
| 38             | 86806   | 86812   | 86817   | 86823   | 86829   | 86835   | 86841   | 86847   | 86853   | 86859   |
| 39             | 86864   | 86870   | 86876   | 86882   | 86888   | 86894   | 86900   | 86906   | 86911   | 86917   |
| 740            | 2.86923 | 2.86929 | 2.86935 | 2.86941 | 2.86947 | 2.86953 | 2.86958 | 2.86964 | 2.86970 | 2.86976 |
| 41             | 86982   | 86988   | 86994   | 86999   | 87005   | 87011   | 87017   | 87023   | 87029   | 87035   |
| 42             | 87040   | 87046   | 87052   | 87058   | 87064   | 87070   | 87075   | 87081   | 87087   | 87093   |
| 43             | 87099   | 87105   | 87111   | 87116   | 87122   | 87128   | 87134   | 87140   | 87146   | 87151   |
| 44             | 87157   | 87163   | 87169   | 87175   | 87181   | 87186   | 87192   | 87198   | 87204   | 87210   |
| 45             | 87216   | 87221   | 87227   | 87233   | 87239   | 87245   | 87251   | 87256   | 87262   | 87268   |
| 46             | 87274   | 87280   | 87286   | 87291   | 87297   | 87303   | 87309   | 87315   | 87320   | 87326   |
| 47             | 87332   | 87338   | 87344   | 87349   | 87355   | 87361   | 87367   | 87373   | 87379   | 87384   |
| 48             | 87390   | 87396   | 87402   | 87408   | 87413   | 87419   | 87425   | 87431   | 87437   | 87443   |
| 49             | 87448   | 87454   | 87460   | 87466   | 87471   | 87477   | 87483   | 87489   | 87495   | 87500   |
| 750            | 2.87506 | 2.87512 | 2.87518 | 2.87523 | 2.87529 | 2.87535 | 2.87541 | 2.87547 | 2.87552 | 2.87558 |
| 51             | 87564   | 87570   | 87576   | 87581   | 87587   | 87593   | 87599   | 87604   | 87610   | 87616   |
| 52             | 87622   | 87628   | 87633   | 87639   | 87645   | 87651   | 87656   | 87662   | 87668   | 87674   |
| 53             | 87679   | 87685   | 87691   | 87697   | 87703   | 87708   | 87714   | 87720   | 87726   | 87731   |
| 54             | 87737   | 87743   | 87749   | 87754   | 87760   | 87766   | 87772   | 87777   | 87783   | 87789   |
| 55             | 87795   | 87800   | 87806   | 87812   | 87818   | 87823   | 87829   | 87835   | 87841   | 87846   |
| 56             | 87852   | 87858   | 87864   | 87869   | 87875   | 87881   | 87887   | 87892   | 87898   | 87904   |
| 57             | 87910   | 87915   | 87921   | 87927   | 87933   | 87938   | 87944   | 87950   | 87955   | 87961   |
| 58             | 87967   | 87973   | 87978   | 87984   | 87990   | 87996   | 88001   | 88007   | 88013   | 88018   |
| 759            | 88024   | 88030   | 88036   | 88041   | 88047   | 88053   | 88058   | 88064   | 88070   | 88076   |



TABLE IV.

A Table of Logarithms from 1 to 10,000.

| Nº  | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|-----|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 760 | 2.88081 | 2.88087 | 2.88093 | 2.88098 | 2.88104 | 2.88110 | 2.88116 | 2.88121 | 2.88127 | 2.88133 |
| 61  | 88138   | 88144   | 88150   | 88156   | 88161   | 88167   | 88173   | 88178   | 88184   | 88190   |
| 62  | 88195   | 88201   | 88207   | 88213   | 88218   | 88224   | 88230   | 88235   | 88241   | 88247   |
| 63  | 88252   | 88258   | 88264   | 88270   | 88275   | 88281   | 88287   | 88292   | 88298   | 88304   |
| 64  | 88309   | 88315   | 88321   | 88326   | 88332   | 88338   | 88343   | 88349   | 88355   | 88360   |
| 65  | 88366   | 88372   | 88377   | 88383   | 88389   | 88395   | 88400   | 88406   | 88412   | 88417   |
| 66  | 88423   | 88429   | 88434   | 88440   | 88446   | 88451   | 88457   | 88463   | 88468   | 88474   |
| 67  | 88480   | 88485   | 88491   | 88497   | 88502   | 88508   | 88513   | 88519   | 88525   | 88530   |
| 68  | 88536   | 88542   | 88547   | 88553   | 88559   | 88564   | 88570   | 88576   | 88581   | 88587   |
| 69  | 88593   | 88598   | 88604   | 88610   | 88615   | 88621   | 88627   | 88632   | 88638   | 88643   |
| 770 | 2.88649 | 2.88655 | 2.88660 | 2.88666 | 2.88672 | 2.88677 | 2.88683 | 2.88689 | 2.88694 | 2.88700 |
| 71  | 88705   | 88711   | 88717   | 88722   | 88728   | 88733   | 88739   | 88745   | 88750   | 88756   |
| 72  | 88762   | 88767   | 88773   | 88779   | 88784   | 88790   | 88795   | 88801   | 88807   | 88812   |
| 73  | 88818   | 88824   | 88829   | 88835   | 88840   | 88846   | 88852   | 88857   | 88863   | 88868   |
| 74  | 88874   | 88880   | 88885   | 88891   | 88897   | 88902   | 88908   | 88913   | 88919   | 88925   |
| 75  | 88930   | 88936   | 88941   | 88947   | 88953   | 88958   | 88964   | 88969   | 88975   | 88981   |
| 76  | 88986   | 88992   | 88997   | 89003   | 89009   | 89014   | 89020   | 89025   | 89031   | 89037   |
| 77  | 89042   | 89048   | 89053   | 89059   | 89064   | 89070   | 89076   | 89081   | 89087   | 89092   |
| 78  | 89098   | 89104   | 89109   | 89115   | 89120   | 89126   | 89131   | 89137   | 89143   | 89148   |
| 79  | 89154   | 89159   | 89165   | 89170   | 89176   | 89182   | 89187   | 89193   | 89198   | 89204   |
| 780 | 2.89209 | 2.89215 | 2.89221 | 2.89226 | 2.89232 | 2.89237 | 2.89243 | 2.89248 | 2.89254 | 2.89260 |
| 81  | 89265   | 89271   | 89276   | 89282   | 89287   | 89293   | 89298   | 89304   | 89310   | 89315   |
| 82  | 89321   | 89326   | 89332   | 89337   | 89343   | 89348   | 89354   | 89360   | 89365   | 89371   |
| 83  | 89376   | 89382   | 89387   | 89393   | 89398   | 89404   | 89409   | 89415   | 89421   | 89426   |
| 84  | 89432   | 89437   | 89443   | 89448   | 89454   | 89459   | 89465   | 89470   | 89476   | 89481   |
| 85  | 89487   | 89492   | 89498   | 89504   | 89509   | 89515   | 89520   | 89526   | 89531   | 89537   |
| 86  | 89542   | 89548   | 89553   | 89559   | 89564   | 89570   | 89575   | 89581   | 89586   | 89592   |
| 87  | 89597   | 89603   | 89609   | 89614   | 89620   | 89625   | 89631   | 89636   | 89642   | 89647   |
| 88  | 89653   | 89658   | 89664   | 89669   | 89675   | 89680   | 89686   | 89691   | 89697   | 89702   |
| 89  | 89708   | 89713   | 89719   | 89724   | 89730   | 89735   | 89741   | 89746   | 89752   | 89757   |
| 790 | 2.89763 | 2.89768 | 2.89774 | 2.89779 | 2.89785 | 2.89790 | 2.89796 | 2.89801 | 2.89807 | 2.89812 |
| 91  | 89818   | 89823   | 89829   | 89834   | 89840   | 89845   | 89851   | 89856   | 89862   | 89867   |
| 92  | 89873   | 89878   | 89883   | 89889   | 89894   | 89900   | 89905   | 89911   | 89916   | 89922   |
| 93  | 89927   | 89933   | 89938   | 89944   | 89949   | 89955   | 89960   | 89966   | 89971   | 89977   |
| 94  | 89982   | 89988   | 89993   | 89999   | 90004   | 90009   | 90015   | 90020   | 90026   | 90031   |
| 95  | 90037   | 90042   | 90048   | 90053   | 90059   | 90064   | 90069   | 90075   | 90080   | 90086   |
| 96  | 90091   | 90097   | 90102   | 90108   | 90113   | 90119   | 90124   | 90129   | 90135   | 90140   |
| 97  | 90146   | 90151   | 90157   | 90162   | 90168   | 90173   | 90179   | 90184   | 90189   | 90195   |
| 98  | 90200   | 90206   | 90211   | 90217   | 90222   | 90227   | 90233   | 90238   | 90244   | 90249   |
| 99  | 90255   | 90260   | 90266   | 90271   | 90276   | 90282   | 90287   | 90293   | 90298   | 90304   |
| 800 | 2.90309 | 2.90314 | 2.90320 | 2.90325 | 2.90331 | 2.90336 | 2.90342 | 2.90347 | 2.90352 | 2.90358 |
| 01  | 90363   | 90369   | 90374   | 90380   | 90385   | 90390   | 90396   | 90401   | 90407   | 90412   |
| 02  | 90417   | 90423   | 90428   | 90434   | 90439   | 90445   | 90450   | 90455   | 90461   | 90466   |
| 03  | 90472   | 90477   | 90482   | 90488   | 90493   | 90499   | 90504   | 90509   | 90515   | 90520   |
| 04  | 90526   | 90531   | 90536   | 90542   | 90547   | 90553   | 90558   | 90563   | 90569   | 90574   |
| 05  | 90580   | 90585   | 90590   | 90596   | 90601   | 90607   | 90612   | 90617   | 90623   | 90628   |
| 06  | 90634   | 90639   | 90644   | 90650   | 90655   | 90660   | 90666   | 90671   | 90677   | 90682   |
| 07  | 90687   | 90693   | 90698   | 90703   | 90709   | 90714   | 90720   | 90725   | 90730   | 90736   |
| 08  | 90741   | 90747   | 90752   | 90757   | 90763   | 90768   | 90773   | 90779   | 90784   | 90789   |
| 09  | 90795   | 90800   | 90806   | 90811   | 90816   | 90822   | 90827   | 90832   | 90838   | 90843   |
| 810 | 2.90849 | 2.90854 | 2.90859 | 2.90865 | 2.90870 | 2.90875 | 2.90881 | 2.90886 | 2.90891 | 2.90897 |
| 11  | 90902   | 90907   | 90913   | 90918   | 90924   | 90929   | 90934   | 90940   | 90945   | 90950   |
| 12  | 90956   | 90961   | 90966   | 90972   | 90977   | 90982   | 90988   | 90993   | 90998   | 91004   |
| 13  | 91009   | 91014   | 91020   | 91025   | 91030   | 91036   | 91041   | 91046   | 91052   | 91057   |
| 14  | 91062   | 91068   | 91073   | 91078   | 91084   | 91089   | 91094   | 91100   | 91105   | 91110   |
| 15  | 91116   | 91121   | 91126   | 91132   | 91137   | 91142   | 91148   | 91153   | 91158   | 91164   |
| 16  | 91169   | 91174   | 91180   | 91185   | 91190   | 91196   | 91201   | 91206   | 91212   | 91217   |
| 17  | 91222   | 91228   | 91233   | 91238   | 91243   | 91249   | 91254   | 91259   | 91265   | 91270   |
| 18  | 91275   | 91281   | 91286   | 91291   | 91297   | 91302   | 91307   | 91312   | 91318   | 91323   |
| 819 | 91328   | 91334   | 91339   | 91344   | 91350   | 91355   | 91360   | 91365   | 91371   | 91376   |

TABLE IV.

A Table of Logarithms from 1 to 10,000.

| N  | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|----|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1  | 2.91381 | 2.91387 | 2.91392 | 2.91397 | 2.91403 | 2.91408 | 2.91413 | 2.91418 | 2.91424 | 2.91429 |
| 2  | 91434   | 91440   | 91445   | 91450   | 91455   | 91461   | 91.06   | 91471   | 91477   | 91482   |
| 3  | 91487   | 91492   | 91498   | 91503   | 91508   | 91514   | 91519   | 91524   | 91529   | 91535   |
| 4  | 91540   | 91545   | 91551   | 91556   | 91561   | 91566   | 91572   | 91577   | 91582   | 91587   |
| 5  | 91593   | 91598   | 91603   | 91609   | 91614   | 916.9   | 91624   | 91630   | 91635   | 91640   |
| 6  | 91645   | 91651   | 91656   | 91661   | 91666   | 91672   | 91677   | 91682   | 91687   | 91693   |
| 7  | 91698   | 91703   | 91709   | 91714   | 91719   | 91724   | 91730   | 91735   | 91740   | 91745   |
| 8  | 91751   | 91756   | 91761   | 91766   | 91772   | 91777   | 91782   | 91787   | 91793   | 91798   |
| 9  | 91803   | 91808   | 91814   | 91819   | 91824   | 91829   | 91834   | 91840   | 91845   | 91850   |
| 10 | 91855   | 91861   | 91866   | 91871   | 91876   | 91882   | 91887   | 91892   | 91897   | 91903   |
| 11 | 2.91908 | 2.91913 | 2.91918 | 2.91924 | 2.91929 | 2.91934 | 2.91939 | 2.91944 | 2.91950 | 2.91955 |
| 12 | 91960   | 91965   | 91971   | 91976   | 91981   | 91986   | 91991   | 91997   | 92002   | 92007   |
| 13 | 92012   | 92018   | 92023   | 92028   | 92033   | 92038   | 92044   | 92049   | 92054   | 92059   |
| 14 | 92065   | 92070   | 92075   | 92080   | 92085   | 92091   | 92096   | 92101   | 92106   | 92111   |
| 15 | 92117   | 92122   | 92127   | 92132   | 92137   | 92143   | 92148   | 92153   | 92158   | 92163   |
| 16 | 92169   | 92174   | 92179   | 92184   | 92189   | 92195   | 92200   | 92205   | 92210   | 92215   |
| 17 | 92221   | 92226   | 92231   | 92236   | 92241   | 92247   | 92252   | 92257   | 92262   | 92267   |
| 18 | 92273   | 92278   | 92283   | 92288   | 92293   | 92298   | 92304   | 92309   | 92314   | 92319   |
| 19 | 92324   | 92330   | 92335   | 92340   | 92345   | 92350   | 92355   | 92361   | 92366   | 92371   |
| 20 | 92376   | 92381   | 92387   | 92392   | 92397   | 92402   | 92407   | 92412   | 92418   | 92423   |
| 21 | 2.92428 | 2.92433 | 2.92438 | 2.92443 | 2.92449 | 2.92454 | 2.92459 | 2.92464 | 2.92469 | 2.92474 |
| 22 | 92480   | 92485   | 92490   | 92495   | 92500   | 92505   | 92511   | 92516   | 92521   | 92526   |
| 23 | 92531   | 92536   | 92542   | 92547   | 92552   | 92557   | 92562   | 92567   | 92572   | 92578   |
| 24 | 92583   | 92588   | 92593   | 92598   | 92603   | 92609   | 92614   | 92619   | 92624   | 92629   |
| 25 | 92634   | 92639   | 92645   | 92650   | 92655   | 92660   | 92665   | 92670   | 92675   | 92681   |
| 26 | 92686   | 92691   | 92696   | 92701   | 92706   | 92711   | 92716   | 92722   | 92727   | 92732   |
| 27 | 92737   | 92742   | 92747   | 92752   | 92758   | 92763   | 92768   | 92773   | 92778   | 92783   |
| 28 | 92788   | 92793   | 92799   | 92804   | 92809   | 92814   | 92819   | 92824   | 92829   | 92834   |
| 29 | 92840   | 92845   | 92850   | 92855   | 92860   | 92865   | 92870   | 92875   | 92881   | 92886   |
| 30 | 92891   | 92896   | 92901   | 92906   | 92911   | 92916   | 92921   | 92927   | 92932   | 92937   |
| 31 | 2.92942 | 2.92947 | 2.92952 | 2.92957 | 2.92962 | 2.92967 | 2.92973 | 2.92978 | 2.92983 | 2.92988 |
| 32 | 92993   | 92998   | 93003   | 93008   | 93013   | 93018   | 93024   | 93029   | 93034   | 93039   |
| 33 | 93044   | 93049   | 93054   | 93059   | 93064   | 93069   | 93075   | 93080   | 93085   | 93090   |
| 34 | 93095   | 93100   | 93105   | 93110   | 93115   | 93120   | 93125   | 93131   | 93136   | 93141   |
| 35 | 93146   | 93151   | 93156   | 93161   | 93166   | 93171   | 93176   | 93181   | 93186   | 93192   |
| 36 | 93197   | 93202   | 93207   | 93212   | 93217   | 93222   | 93227   | 93232   | 93237   | 93242   |
| 37 | 93247   | 93252   | 93258   | 93263   | 93268   | 93273   | 93278   | 93283   | 93288   | 93293   |
| 38 | 93298   | 93303   | 93308   | 93313   | 93318   | 93323   | 93328   | 93334   | 93339   | 93344   |
| 39 | 93349   | 93354   | 93359   | 93364   | 93369   | 93374   | 93379   | 93384   | 93389   | 93394   |
| 40 | 93399   | 93404   | 93409   | 93414   | 93420   | 93425   | 93430   | 93435   | 93440   | 93445   |
| 41 | 2.93450 | 2.93455 | 2.93460 | 2.93465 | 2.93470 | 2.93475 | 2.93480 | 2.93485 | 2.93490 | 2.93495 |
| 42 | 93500   | 93505   | 93510   | 93515   | 93520   | 93526   | 93531   | 93536   | 93541   | 93546   |
| 43 | 93551   | 93556   | 93561   | 93566   | 93571   | 93576   | 93581   | 93586   | 93591   | 93596   |
| 44 | 93601   | 93606   | 93611   | 93616   | 93621   | 93626   | 93631   | 93636   | 93641   | 93646   |
| 45 | 93651   | 93656   | 93661   | 93666   | 93671   | 93676   | 93682   | 93687   | 93692   | 93697   |
| 46 | 93702   | 93707   | 93712   | 93717   | 93722   | 93727   | 93732   | 93737   | 93742   | 93747   |
| 47 | 93752   | 93757   | 93762   | 93767   | 93772   | 93777   | 93782   | 93787   | 93792   | 93797   |
| 48 | 93802   | 93807   | 93812   | 93817   | 93822   | 93827   | 93832   | 93837   | 93842   | 93847   |
| 49 | 93852   | 93857   | 93862   | 93867   | 93872   | 93877   | 93882   | 93887   | 93892   | 93897   |
| 50 | 93902   | 93907   | 93912   | 93917   | 93922   | 93927   | 93932   | 93937   | 93942   | 93947   |
| 51 | 2.93952 | 2.93957 | 2.93962 | 2.93967 | 2.93972 | 2.93977 | 2.93982 | 2.93987 | 2.93992 | 2.93997 |
| 52 | 94002   | 94007   | 94012   | 94017   | 94022   | 94027   | 94032   | 94037   | 94042   | 94047   |
| 53 | 94052   | 94057   | 94062   | 94067   | 94072   | 94077   | 94082   | 94086   | 94091   | 94096   |
| 54 | 94101   | 94106   | 94111   | 94116   | 94121   | 94126   | 94131   | 94136   | 94141   | 94146   |
| 55 | 94151   | 94156   | 94161   | 94166   | 94171   | 94176   | 94181   | 94186   | 94191   | 94196   |
| 56 | 94201   | 94206   | 94211   | 94216   | 94221   | 94226   | 94231   | 94236   | 94240   | 94245   |
| 57 | 94250   | 94255   | 94260   | 94265   | 94270   | 94275   | 94280   | 94285   | 94290   | 94295   |
| 58 | 94300   | 94305   | 94310   | 94315   | 94320   | 94325   | 94330   | 94335   | 94340   | 94345   |
| 59 | 94349   | 94354   | 94359   | 94364   | 94369   | 94374   | 94379   | 94384   | 94389   | 94394   |
| 60 | 94399   | 94404   | 94409   | 94414   | 94419   | 94424   | 94429   | 94433   | 94438   | 94443   |

TABLE IV.

A Table of Logarithms from 1 to 10,000.

| N <sup>o</sup> | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|----------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 880            | 2.94448 | 2.94453 | 2.94458 | 2.94463 | 2.94468 | 2.94473 | 2.94478 | 2.94483 | 2.94488 | 2.94493 |
| 81             | 94498   | 94503   | 94507   | 94512   | 94517   | 94522   | 94527   | 94532   | 94537   | 94542   |
| 82             | 94547   | 94552   | 94557   | 94562   | 94567   | 94571   | 94576   | 94581   | 94586   | 94591   |
| 83             | 94596   | 94601   | 94606   | 94611   | 94616   | 94621   | 94626   | 94630   | 94635   | 94640   |
| 84             | 94645   | 94650   | 94655   | 94660   | 94665   | 94670   | 94675   | 94680   | 94685   | 94690   |
| 85             | 94694   | 94699   | 94704   | 94709   | 94714   | 94719   | 94724   | 94729   | 94734   | 94739   |
| 86             | 94743   | 94748   | 94753   | 94758   | 94763   | 94768   | 94773   | 94778   | 94783   | 94788   |
| 87             | 94792   | 94797   | 94802   | 94807   | 94812   | 94817   | 94822   | 94827   | 94832   | 94837   |
| 88             | 94841   | 94846   | 94851   | 94856   | 94861   | 94866   | 94871   | 94876   | 94880   | 94885   |
| 89             | 94890   | 94895   | 94900   | 94905   | 94910   | 94915   | 94919   | 94924   | 94929   | 94934   |
| 890            | 2.94939 | 2.94944 | 2.94949 | 2.94954 | 2.94959 | 2.94963 | 2.94968 | 2.94973 | 2.94978 | 2.94983 |
| 91             | 94988   | 94993   | 94998   | 95002   | 95007   | 95012   | 95017   | 95022   | 95027   | 95032   |
| 92             | 95036   | 95041   | 95046   | 95051   | 95056   | 95061   | 95066   | 95071   | 95075   | 95080   |
| 93             | 95085   | 95090   | 95095   | 95100   | 95105   | 95109   | 95114   | 95119   | 95124   | 95129   |
| 94             | 95134   | 95139   | 95143   | 95148   | 95153   | 95158   | 95163   | 95168   | 95173   | 95178   |
| 95             | 95182   | 95187   | 95192   | 95197   | 95202   | 95207   | 95211   | 95216   | 95221   | 95226   |
| 96             | 95231   | 95236   | 95240   | 95245   | 95250   | 95255   | 95260   | 95265   | 95270   | 95275   |
| 97             | 95279   | 95284   | 95289   | 95294   | 95299   | 95303   | 95308   | 95313   | 95318   | 95323   |
| 98             | 95328   | 95332   | 95337   | 95342   | 95347   | 95352   | 95357   | 95361   | 95366   | 95371   |
| 99             | 95376   | 95381   | 95386   | 95390   | 95395   | 95400   | 95405   | 95410   | 95415   | 95420   |
| 900            | 2.95424 | 2.95429 | 2.95434 | 2.95439 | 2.95444 | 2.95448 | 2.95453 | 2.95458 | 2.95463 | 2.95468 |
| 01             | 95472   | 95477   | 95482   | 95487   | 95492   | 95497   | 95501   | 95506   | 95511   | 95516   |
| 02             | 95521   | 95525   | 95530   | 95535   | 95540   | 95545   | 95550   | 95554   | 95559   | 95564   |
| 03             | 95569   | 95574   | 95578   | 95583   | 95588   | 95593   | 95598   | 95602   | 95607   | 95612   |
| 04             | 95617   | 95622   | 95626   | 95631   | 95636   | 95641   | 95646   | 95650   | 95655   | 95660   |
| 05             | 95665   | 95670   | 95674   | 95679   | 95684   | 95689   | 95694   | 95698   | 95703   | 95708   |
| 06             | 95713   | 95718   | 95722   | 95727   | 95732   | 95737   | 95742   | 95746   | 95751   | 95756   |
| 07             | 95761   | 95766   | 95770   | 95775   | 95780   | 95785   | 95789   | 95794   | 95799   | 95804   |
| 08             | 95809   | 95813   | 95818   | 95823   | 95828   | 95832   | 95837   | 95842   | 95847   | 95852   |
| 09             | 95856   | 95861   | 95866   | 95871   | 95875   | 95880   | 95885   | 95890   | 95895   | 95900   |
| 910            | 2.95904 | 2.95909 | 2.95914 | 2.95918 | 2.95923 | 2.95928 | 2.95933 | 2.95938 | 2.95942 | 2.95947 |
| 11             | 95952   | 95957   | 95961   | 95966   | 95971   | 95976   | 95980   | 95985   | 95990   | 95995   |
| 12             | 95999   | 96004   | 96009   | 96014   | 96019   | 96023   | 96028   | 96033   | 96038   | 96043   |
| 13             | 96047   | 96052   | 96057   | 96061   | 96066   | 96071   | 96076   | 96080   | 96085   | 96090   |
| 14             | 96095   | 96099   | 96104   | 96109   | 96114   | 96118   | 96123   | 96128   | 96133   | 96138   |
| 15             | 96142   | 96147   | 96152   | 96156   | 96161   | 96166   | 96171   | 96175   | 96180   | 96185   |
| 16             | 96190   | 96194   | 96199   | 96204   | 96209   | 96213   | 96218   | 96223   | 96227   | 96232   |
| 17             | 96237   | 96242   | 96246   | 96251   | 96256   | 96261   | 96265   | 96270   | 96275   | 96280   |
| 18             | 96284   | 96289   | 96294   | 96298   | 96303   | 96308   | 96313   | 96317   | 96322   | 96327   |
| 19             | 96332   | 96336   | 96341   | 96346   | 96350   | 96355   | 96360   | 96365   | 96369   | 96374   |
| 920            | 2.96379 | 2.96384 | 2.96388 | 2.96393 | 2.96398 | 2.96402 | 2.96407 | 2.96412 | 2.96417 | 2.96422 |
| 21             | 96426   | 96431   | 96435   | 96440   | 96445   | 96450   | 96454   | 96459   | 96464   | 96469   |
| 22             | 96473   | 96478   | 96483   | 96487   | 96492   | 96497   | 96501   | 96506   | 96511   | 96516   |
| 23             | 96520   | 96525   | 96530   | 96534   | 96539   | 96544   | 96548   | 96553   | 96558   | 96563   |
| 24             | 96567   | 96572   | 96577   | 96581   | 96586   | 96591   | 96595   | 96600   | 96605   | 96610   |
| 25             | 96614   | 96619   | 96624   | 96628   | 96633   | 96638   | 96642   | 96647   | 96652   | 96657   |
| 26             | 96661   | 96666   | 96670   | 96675   | 96680   | 96685   | 96689   | 96694   | 96699   | 96704   |
| 27             | 96708   | 96713   | 96717   | 96722   | 96727   | 96731   | 96736   | 96741   | 96745   | 96750   |
| 28             | 96755   | 96759   | 96764   | 96769   | 96774   | 96778   | 96783   | 96788   | 96792   | 96797   |
| 29             | 96802   | 96806   | 96811   | 96816   | 96820   | 96825   | 96830   | 96834   | 96839   | 96844   |
| 930            | 2.96848 | 2.96853 | 2.96858 | 2.96862 | 2.96867 | 2.96872 | 2.96876 | 2.96881 | 2.96886 | 2.96891 |
| 31             | 96895   | 96900   | 96904   | 96909   | 96914   | 96918   | 96923   | 96928   | 96932   | 96937   |
| 32             | 96942   | 96946   | 96951   | 96956   | 96960   | 96965   | 96970   | 96974   | 96979   | 96984   |
| 33             | 96988   | 96993   | 96997   | 97002   | 97007   | 97011   | 97016   | 97021   | 97025   | 97030   |
| 34             | 97035   | 97039   | 97044   | 97049   | 97053   | 97058   | 97063   | 97067   | 97072   | 97077   |
| 35             | 97081   | 97086   | 97090   | 97095   | 97100   | 97104   | 97109   | 97114   | 97118   | 97123   |
| 36             | 97128   | 97132   | 97137   | 97142   | 97146   | 97151   | 97155   | 97160   | 97165   | 97170   |
| 37             | 97174   | 97179   | 97183   | 97188   | 97192   | 97197   | 97202   | 97206   | 97211   | 97216   |
| 38             | 97220   | 97225   | 97230   | 97234   | 97239   | 97243   | 97248   | 97253   | 97257   | 97262   |
| 939            | 97267   | 97271   | 97276   | 97280   | 97285   | 97290   | 97294   | 97299   | 97304   | 97309   |



TABLE IV.

A Table of Logarithms from 1 to 10,000.

|       | 0       | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 2.944 | 2.97313 | 2.97317 | 2.67322 | 2.97327 | 2.97331 | 2.97336 | 2.97340 | 2.97345 | 2.97350 | 2.97354 |
| 945   | 97359   | 97364   | 97368   | 97373   | 97377   | 97382   | 97387   | 97391   | 97396   | 97400   |
| 946   | 97405   | 97410   | 97414   | 97419   | 97424   | 97428   | 97433   | 97437   | 97442   | 97447   |
| 947   | 97451   | 97456   | 97460   | 97465   | 97470   | 97474   | 97479   | 97483   | 97488   | 97493   |
| 948   | 97497   | 97502   | 97506   | 97511   | 97516   | 97520   | 97525   | 97529   | 97534   | 97539   |
| 949   | 97543   | 97548   | 97552   | 97557   | 97562   | 97566   | 97571   | 97575   | 97580   | 97585   |
| 950   | 97589   | 97594   | 97598   | 97603   | 97607   | 97612   | 97617   | 97621   | 97626   | 97630   |
| 951   | 97635   | 97640   | 97644   | 97649   | 97653   | 97658   | 97663   | 97667   | 97672   | 97676   |
| 952   | 97681   | 97685   | 97690   | 97695   | 97699   | 97704   | 97708   | 97713   | 97717   | 97722   |
| 953   | 97727   | 97731   | 97736   | 97740   | 97745   | 97749   | 97754   | 97759   | 97763   | 97768   |
| 954   | 2.97772 | 2.97777 | 2.97782 | 2.97786 | 2.97791 | 2.97795 | 2.97800 | 2.97804 | 2.97809 | 2.97813 |
| 955   | 97818   | 97823   | 97827   | 97832   | 97836   | 97841   | 97845   | 97850   | 97855   | 97859   |
| 956   | 97864   | 97868   | 97873   | 97877   | 97882   | 97886   | 97891   | 97896   | 97900   | 97905   |
| 957   | 97909   | 97914   | 97918   | 97923   | 97928   | 97932   | 97937   | 97941   | 97946   | 97950   |
| 958   | 97955   | 97959   | 97964   | 97968   | 97973   | 97978   | 97982   | 97987   | 97991   | 97996   |
| 959   | 98000   | 98005   | 98009   | 98014   | 98019   | 98023   | 98028   | 98032   | 98037   | 98041   |
| 960   | 98046   | 98050   | 98055   | 98059   | 98064   | 98068   | 98073   | 98078   | 98082   | 98087   |
| 961   | 98091   | 98096   | 98100   | 98105   | 98109   | 98114   | 98118   | 98123   | 98127   | 98132   |
| 962   | 98137   | 98141   | 98146   | 98150   | 98155   | 98159   | 98164   | 98168   | 98173   | 98177   |
| 963   | 98182   | 98186   | 98191   | 98195   | 98200   | 98204   | 98209   | 98214   | 98218   | 98223   |
| 964   | 2.98227 | 2.98232 | 2.98236 | 2.98241 | 2.98245 | 2.98250 | 2.98254 | 2.98259 | 2.98263 | 2.98268 |
| 965   | 98272   | 98277   | 98281   | 98286   | 98290   | 98295   | 98299   | 98304   | 98308   | 98313   |
| 966   | 98318   | 98322   | 98327   | 98331   | 98336   | 98340   | 98345   | 98349   | 98354   | 98358   |
| 967   | 98363   | 98367   | 98372   | 98376   | 98381   | 98385   | 98390   | 98394   | 98399   | 98403   |
| 968   | 98408   | 98412   | 98417   | 98421   | 98426   | 98430   | 98435   | 98439   | 98444   | 98448   |
| 969   | 98453   | 98457   | 98462   | 98466   | 98471   | 98475   | 98480   | 98484   | 98489   | 98493   |
| 970   | 98498   | 98502   | 98507   | 98511   | 98516   | 98520   | 98525   | 98529   | 98534   | 98538   |
| 971   | 98543   | 98547   | 98552   | 98556   | 98561   | 98565   | 98570   | 98574   | 98579   | 98583   |
| 972   | 98588   | 98592   | 98597   | 98601   | 98605   | 98610   | 98614   | 98619   | 98623   | 98628   |
| 973   | 98632   | 98637   | 98641   | 98646   | 98650   | 98655   | 98659   | 98664   | 98668   | 98673   |
| 974   | 2.98677 | 2.98682 | 2.98686 | 2.98691 | 2.98695 | 2.98700 | 2.98704 | 2.98709 | 2.98713 | 2.98717 |
| 975   | 98722   | 98726   | 98731   | 98735   | 98740   | 98744   | 98749   | 98753   | 98758   | 98762   |
| 976   | 98767   | 98771   | 98776   | 98780   | 98784   | 98789   | 98793   | 98798   | 98802   | 98807   |
| 977   | 98811   | 98816   | 98820   | 98825   | 98829   | 98834   | 98838   | 98843   | 98847   | 98851   |
| 978   | 98856   | 98860   | 98865   | 98869   | 98874   | 98878   | 98883   | 98887   | 98892   | 98896   |
| 979   | 98900   | 98905   | 98909   | 98914   | 98918   | 98923   | 98927   | 98932   | 98936   | 98941   |
| 980   | 98945   | 98949   | 98954   | 98958   | 98963   | 98967   | 98972   | 98976   | 98981   | 98985   |
| 981   | 98989   | 98994   | 98998   | 99003   | 99007   | 99012   | 99016   | 99021   | 99025   | 99029   |
| 982   | 99034   | 99038   | 99043   | 99047   | 99052   | 99056   | 99061   | 99065   | 99069   | 99074   |
| 983   | 99078   | 99083   | 99087   | 99092   | 99096   | 99100   | 99105   | 99109   | 99114   | 99118   |
| 984   | 2.99123 | 2.99127 | 2.99131 | 2.99136 | 2.99140 | 2.99145 | 2.99149 | 2.99154 | 2.99158 | 2.99162 |
| 985   | 99167   | 99171   | 99176   | 99180   | 99185   | 99189   | 99193   | 99198   | 99202   | 99207   |
| 986   | 99211   | 99216   | 99220   | 99224   | 99229   | 99233   | 99238   | 99242   | 99247   | 99251   |
| 987   | 99255   | 99260   | 99264   | 99269   | 99273   | 99277   | 99282   | 99286   | 99291   | 99295   |
| 988   | 99300   | 99304   | 99308   | 99313   | 99317   | 99322   | 99326   | 99330   | 99335   | 99339   |
| 989   | 99344   | 99348   | 99352   | 99357   | 99361   | 99366   | 99370   | 99374   | 99379   | 99383   |
| 990   | 99388   | 99392   | 99396   | 99401   | 99405   | 99410   | 99414   | 99419   | 99423   | 99427   |
| 991   | 99432   | 99436   | 99441   | 99445   | 99449   | 99454   | 99458   | 99463   | 99467   | 99471   |
| 992   | 99476   | 99480   | 99484   | 99489   | 99493   | 99498   | 99502   | 99506   | 99511   | 99515   |
| 993   | 99520   | 99524   | 99528   | 99533   | 99537   | 99542   | 99546   | 99550   | 99555   | 99559   |
| 994   | 2.99564 | 2.99568 | 2.99572 | 2.99577 | 2.99581 | 2.99585 | 2.99590 | 2.99594 | 2.99599 | 2.99603 |
| 995   | 99607   | 99612   | 99616   | 99621   | 99625   | 99629   | 99634   | 99638   | 99642   | 99647   |
| 996   | 99651   | 99656   | 99660   | 99664   | 99669   | 99673   | 99677   | 99682   | 99686   | 99691   |
| 997   | 99695   | 99699   | 99704   | 99708   | 99712   | 99717   | 99721   | 99726   | 99730   | 99734   |
| 998   | 99739   | 99743   | 99747   | 99752   | 99756   | 99760   | 99765   | 99769   | 99774   | 99778   |
| 999   | 99782   | 99787   | 99791   | 99795   | 99800   | 99804   | 99808   | 99813   | 99817   | 99822   |
| 1000  | 99826   | 99830   | 99835   | 99839   | 99843   | 99848   | 99852   | 99856   | 99861   | 99865   |
| 1001  | 99870   | 99874   | 99878   | 99883   | 99887   | 99891   | 99896   | 99900   | 99904   | 99909   |
| 1002  | 99913   | 99917   | 99922   | 99926   | 99930   | 99935   | 99939   | 99944   | 99948   | 99952   |
| 1003  | 99957   | 99961   | 99965   | 99970   | 99974   | 99978   | 99983   | 99987   | 99991   | 99996   |

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 0 Degree

| M.       | Sine.    | Co-sine. | Tangent. | Co-tang.  | Secant.    | Co-secant. |    |
|----------|----------|----------|----------|-----------|------------|------------|----|
| 0        | 10.00000 | 10.00000 | 10.00000 | Infinite. | 10.00000   | Infinite.  | 60 |
| 1        | 6.46373  | 00000    | 6.46373  | 13.53627  | 10.00000   | 13.53627   | 59 |
| 2        | 76476    | 00000    | 76470    | 23524     | 00000      | 23524      | 58 |
| 3        | 94085    | 00000    | 94085    | 05915     | 00000      | 05915      | 57 |
| 4        | 7.06579  | 00000    | 7.06579  | 12.93421  | 00000      | 12.93421   | 56 |
| 5        | 16270    | 00000    | 16270    | 83730     | 00000      | 83730      | 55 |
| 6        | 24188    | 00000    | 24188    | 75812     | 00000      | 75812      | 54 |
| 7        | 30882    | 00000    | 30882    | 69118     | 00000      | 69118      | 53 |
| 8        | 36681    | 00000    | 36682    | 63318     | 00000      | 63318      | 52 |
| 9        | 41797    | 00000    | 41797    | 58203     | 00000      | 58203      | 51 |
| 10       | 46373    | 00000    | 46373    | 53627     | 00000      | 53627      | 50 |
| 11       | 7.40512  | 10.00000 | 7.50512  | 12.49488  | 10.00000   | 12.49488   | 49 |
| 12       | 54291    | 00000    | 54291    | 45709     | 00000      | 45709      | 48 |
| 13       | 57767    | 00000    | 57767    | 42233     | 00000      | 42233      | 47 |
| 14       | 60985    | 00000    | 60986    | 39014     | 00000      | 39015      | 46 |
| 15       | 63982    | 00000    | 63982    | 36018     | 00000      | 36018      | 45 |
| 16       | 66784    | 00000    | 66785    | 33215     | 00000      | 33216      | 44 |
| 17       | 69417    | 9.99999  | 69418    | 30582     | 00000      | 30583      | 43 |
| 18       | 71900    | 99999    | 71900    | 28100     | 00001      | 28100      | 42 |
| 19       | 74248    | 99999    | 74248    | 25752     | 00001      | 25752      | 41 |
| 20       | 76475    | 99999    | 76476    | 23524     | 00001      | 23525      | 40 |
| 21       | 7.78594  | 9.99999  | 7.78595  | 12.21405  | 10.00001   | 12.21406   | 39 |
| 22       | 80615    | 99999    | 80615    | 19385     | 00001      | 19385      | 38 |
| 23       | 82545    | 99999    | 82546    | 17454     | 00001      | 17455      | 37 |
| 24       | 84393    | 99999    | 84394    | 15606     | 00001      | 15607      | 36 |
| 25       | 86166    | 99999    | 86167    | 13833     | 00001      | 13834      | 35 |
| 26       | 87870    | 99999    | 87871    | 12130     | 00001      | 12130      | 34 |
| 27       | 89509    | 99999    | 89510    | 10490     | 00001      | 10491      | 33 |
| 28       | 92088    | 99999    | 92089    | 08911     | 00001      | 08912      | 32 |
| 29       | 92612    | 99999    | 92613    | 07387     | 00002      | 07388      | 31 |
| 30       | 94084    | 99999    | 94086    | 05914     | 00002      | 05915      | 30 |
| 31       | 7.95508  | 9.99998  | 7.95510  | 12.04490  | 10.00002   | 12.04492   | 29 |
| 32       | 96887    | 99998    | 96889    | 03111     | 00002      | 03113      | 28 |
| 33       | 98223    | 99998    | 98225    | 01775     | 00002      | 01777      | 27 |
| 34       | 99520    | 99998    | 99522    | 00478     | 00002      | 00480      | 26 |
| 35       | 8.00779  | 99998    | 8.00781  | 11.99219  | 00002      | 11.99221   | 25 |
| 36       | 02002    | 99998    | 02004    | 97996     | 00002      | 97998      | 24 |
| 37       | 03192    | 99997    | 03194    | 96805     | 00002      | 96808      | 23 |
| 38       | 04350    | 99997    | 04353    | 95647     | 00003      | 95650      | 22 |
| 39       | 05478    | 99997    | 05481    | 94519     | 00003      | 94522      | 21 |
| 40       | 06578    | 99997    | 06581    | 93419     | 00003      | 93422      | 20 |
| 41       | 8.07650  | 9.99997  | 8.07653  | 11.92347  | 10.00003   | 11.92350   | 19 |
| 42       | 08696    | 99997    | 08700    | 91300     | 00003      | 91304      | 18 |
| 43       | 09718    | 99997    | 09722    | 90278     | 00003      | 90281      | 17 |
| 44       | 10717    | 99996    | 10720    | 89280     | 00004      | 89283      | 16 |
| 45       | 11693    | 99996    | 11696    | 88304     | 00004      | 88307      | 15 |
| 46       | 12647    | 99996    | 12651    | 87349     | 00004      | 87356      | 14 |
| 47       | 13581    | 99996    | 13585    | 86415     | 00004      | 86419      | 13 |
| 48       | 14495    | 99996    | 14500    | 85500     | 00004      | 85505      | 12 |
| 49       | 15391    | 99996    | 15395    | 84605     | 00005      | 84609      | 11 |
| 50       | 16268    | 99995    | 16273    | 83727     | 00005      | 83732      | 10 |
| 51       | 8.17128  | 9.99995  | 8.27132  | 11.82867  | 10.00005   | 11.82872   | 9  |
| 52       | 17971    | 99995    | 17976    | 82024     | 00005      | 82029      | 8  |
| 53       | 18798    | 99995    | 18804    | 81196     | 00005      | 81202      | 7  |
| 54       | 19610    | 99995    | 19616    | 80384     | 00005      | 80390      | 6  |
| 55       | 20407    | 99994    | 20413    | 79587     | 00006      | 79593      | 5  |
| 56       | 21189    | 99994    | 21195    | 78805     | 00006      | 78811      | 4  |
| 57       | 21958    | 99994    | 21964    | 78036     | 00006      | 78042      | 3  |
| 58       | 22713    | 99994    | 22719    | 77280     | 00006      | 77286      | 2  |
| 59       | 23456    | 99994    | 23462    | 76538     | 00006      | 76544      | 1  |
| 60       | 24186    | 99993    | 24192    | 75808     | 00006      | 75814      | 0  |
| Co-sine. |          | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    | M  |

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 1 Degree.

| M.       | Sine.   | Co-fine. | Tangent. | Co-tang.   | Secant.  | Co-secant. |    |
|----------|---------|----------|----------|------------|----------|------------|----|
| 60       | 8.24185 | 9.99993  | 8.24192  | 11.75808   | 10.00007 | 11.75814   | 60 |
| 59       | 24903   | 99993    | 24910    | 75090      | 00007    | 75097      | 59 |
| 58       | 25609   | 99993    | 25616    | 74384      | 00007    | 74391      | 58 |
| 57       | 26304   | 99993    | 26311    | 73688      | 00007    | 73696      | 57 |
| 56       | 26988   | 99992    | 26996    | 73004      | 00007    | 73012      | 56 |
| 55       | 27661   | 99992    | 27669    | 72331      | 00008    | 72339      | 55 |
| 54       | 28324   | 99992    | 28332    | 71668      | 00008    | 71676      | 54 |
| 53       | 28977   | 99992    | 28985    | 71014      | 00008    | 71023      | 53 |
| 52       | 29621   | 99991    | 29629    | 70371      | 00008    | 70379      | 52 |
| 51       | 30255   | 99991    | 20263    | 79737      | 00009    | 69745      | 51 |
| 50       | 8.30879 | 9.99991  | 8.30888  | 11.69112   | 10.00009 | 11.69121   | 50 |
| 49       | 31495   | 99991    | 31505    | 68495      | 00009    | 68505      | 49 |
| 48       | 32103   | 99990    | 32112    | 67888      | 00009    | 67897      | 48 |
| 47       | 32702   | 99990    | 32711    | 67289      | 00010    | 67298      | 47 |
| 46       | 33292   | 99990    | 33302    | 66697      | 00010    | 66708      | 46 |
| 45       | 33875   | 99989    | 33886    | 66114      | 00010    | 66125      | 45 |
| 44       | 34450   | 99989    | 34461    | 65539      | 00011    | 65550      | 44 |
| 43       | 35018   | 99989    | 35029    | 64971      | 00011    | 64982      | 43 |
| 42       | 35578   | 99989    | 35589    | 64410      | 00011    | 64422      | 42 |
| 41       | 36131   | 99989    | 36143    | 63857      | 00011    | 63868      | 41 |
| 40       | 8.36678 | 9.99988  | 8.36689  | 11.63310   | 10.00012 | 11.63322   | 40 |
| 39       | 37217   | 99988    | 37229    | 62771      | 00012    | 62783      | 39 |
| 38       | 37750   | 99988    | 37762    | 62238      | 00012    | 62250      | 38 |
| 37       | 38276   | 99987    | 38289    | 61711      | 00013    | 61724      | 37 |
| 36       | 38796   | 99987    | 38809    | 61191      | 00013    | 61204      | 36 |
| 35       | 39310   | 99987    | 39323    | 60677      | 00013    | 60690      | 35 |
| 34       | 39818   | 99986    | 39832    | 60168      | 00014    | 60182      | 34 |
| 33       | 40320   | 99986    | 40334    | 59666      | 00014    | 59680      | 33 |
| 32       | 40816   | 99986    | 40830    | 59170      | 00014    | 59184      | 32 |
| 31       | 41307   | 99985    | 41321    | 58679      | 00015    | 58693      | 31 |
| 30       | 8.41792 | 9.99985  | 8.41807  | 11.58193   | 10.00015 | 11.58208   | 30 |
| 29       | 42272   | 99985    | 42287    | 57713      | 00015    | 57728      | 29 |
| 28       | 42746   | 99984    | 42762    | 57238      | 00016    | 57254      | 28 |
| 27       | 43216   | 99984    | 43231    | 56768      | 00016    | 56784      | 27 |
| 26       | 43680   | 99984    | 43696    | 56304      | 00016    | 56320      | 26 |
| 25       | 44139   | 99983    | 44156    | 55844      | 00017    | 55861      | 25 |
| 24       | 44594   | 99983    | 44611    | 55389      | 00017    | 55406      | 24 |
| 23       | 45044   | 99983    | 45061    | 54939      | 00017    | 54956      | 23 |
| 22       | 45489   | 99982    | 45507    | 54493      | 00018    | 54510      | 22 |
| 21       | 45930   | 99982    | 45948    | 54052      | 00018    | 54070      | 21 |
| 20       | 8.46366 | 9.99982  | 8.46385  | 11.53615   | 10.00018 | 11.53633   | 20 |
| 19       | 46798   | 99981    | 46817    | 53183      | 00019    | 53201      | 19 |
| 18       | 47226   | 99981    | 47245    | 52755      | 00019    | 52774      | 18 |
| 17       | 47650   | 99980    | 47669    | 52331      | 00019    | 52350      | 17 |
| 16       | 48069   | 99980    | 48089    | 51911      | 00020    | 51931      | 16 |
| 15       | 48485   | 99980    | 48505    | 51495      | 00020    | 51515      | 15 |
| 14       | 48896   | 99979    | 48917    | 51083      | 00021    | 51104      | 14 |
| 13       | 49304   | 99979    | 49325    | 50675      | 00021    | 50696      | 13 |
| 12       | 49708   | 99979    | 49729    | 50271      | 00021    | 50292      | 12 |
| 11       | 50108   | 99978    | 40130    | 49870      | 00022    | 49892      | 11 |
| 10       | 8.50504 | 9.99978  | 8.50527  | 11.49473   | 10.00022 | 11.49495   | 10 |
| 9        | 50897   | 99977    | 50920    | 49080      | 00023    | 49103      | 9  |
| 8        | 51287   | 99977    | 51310    | 48690      | 00023    | 48713      | 8  |
| 7        | 51673   | 99976    | 51696    | 48304      | 00023    | 48328      | 7  |
| 6        | 52055   | 99976    | 52079    | 47921      | 00024    | 47945      | 6  |
| 5        | 52434   | 99976    | 52459    | 47541      | 00024    | 47566      | 5  |
| 4        | 52810   | 99975    | 52835    | 47165      | 00025    | 47190      | 4  |
| 3        | 53183   | 99975    | 53208    | 46792      | 00025    | 46817      | 3  |
| 2        | 53552   | 99974    | 53578    | 46422      | 00026    | 46448      | 2  |
| 1        | 53919   | 99974    | 53945    | 46055      | 00026    | 46081      | 1  |
| 0        | 54282   | 99973    | 54308    | 45692      | 00026    | 45718      | 0  |
| Co-fine. | Sine.   | Co-tang. | Tangent. | Co-secant. | Secant.  | M.         |    |



TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 2 Degrees.

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 8.54282  | 9.99973  | 8.54309  | 11.45692 | 10.00026   | 11.45718   | 60 |
| 1  | 54642    | 99973    | 54669    | 45331    | 00027      | 45358      | 59 |
| 2  | 54999    | 99973    | 55027    | 44973    | 00027      | 45000      | 58 |
| 3  | 55354    | 99972    | 55382    | 44618    | 00028      | 44646      | 57 |
| 4  | 55705    | 99972    | 55734    | 44266    | 00028      | 44295      | 56 |
| 5  | 56054    | 99971    | 56083    | 43917    | 00029      | 43946      | 55 |
| 6  | 56400    | 99971    | 56429    | 43572    | 00029      | 43600      | 54 |
| 7  | 56743    | 99970    | 56773    | 43227    | 00030      | 43257      | 53 |
| 8  | 57084    | 99970    | 57114    | 42886    | 00030      | 42916      | 52 |
| 9  | 57421    | 99970    | 57452    | 42548    | 00030      | 42579      | 51 |
| 10 | 8.57757  | 9.99969  | 8.57788  | 11.42212 | 10.00031   | 11.42243   | 50 |
| 11 | 58089    | 99968    | 58121    | 41879    | 00031      | 41911      | 49 |
| 12 | 58419    | 99968    | 58451    | 41549    | 00032      | 41581      | 48 |
| 13 | 58747    | 99967    | 58779    | 41221    | 00032      | 41253      | 47 |
| 14 | 59072    | 99967    | 59105    | 40895    | 00033      | 40927      | 46 |
| 15 | 59395    | 99966    | 59428    | 40572    | 00033      | 40605      | 45 |
| 16 | 59715    | 99966    | 59749    | 40251    | 00034      | 40285      | 44 |
| 17 | 60033    | 99965    | 60068    | 39932    | 00034      | 39967      | 43 |
| 18 | 60349    | 99965    | 60384    | 39616    | 00035      | 39651      | 42 |
| 19 | 60662    | 99964    | 60698    | 39302    | 00035      | 39338      | 41 |
| 20 | 8.60973  | 9.99964  | 8.61009  | 11.38991 | 10.00036   | 11.39027   | 40 |
| 21 | 61282    | 99963    | 61319    | 38681    | 00036      | 38718      | 39 |
| 22 | 61589    | 99963    | 61626    | 38374    | 00037      | 38411      | 38 |
| 23 | 61894    | 99962    | 61931    | 38069    | 00038      | 38106      | 37 |
| 24 | 62196    | 99962    | 62234    | 37766    | 00038      | 37804      | 36 |
| 25 | 62496    | 99961    | 62535    | 37465    | 00039      | 37503      | 35 |
| 26 | 62795    | 99961    | 62834    | 37166    | 00039      | 37205      | 34 |
| 27 | 63091    | 99960    | 63131    | 36869    | 00040      | 36909      | 33 |
| 28 | 63385    | 99960    | 63426    | 36574    | 00040      | 36615      | 32 |
| 29 | 63678    | 99959    | 63718    | 36281    | 00041      | 36322      | 31 |
| 30 | 8.63968  | 9.99959  | 8.64009  | 11.35991 | 10.00041   | 11.36032   | 30 |
| 31 | 64256    | 99958    | 64298    | 35702    | 00042      | 35744      | 29 |
| 32 | 64543    | 99957    | 64585    | 35415    | 00042      | 35457      | 28 |
| 33 | 64827    | 99957    | 64870    | 35130    | 00043      | 35173      | 27 |
| 34 | 65110    | 99956    | 65154    | 34846    | 00044      | 34890      | 26 |
| 35 | 65391    | 99956    | 65435    | 34565    | 00044      | 34609      | 25 |
| 36 | 65670    | 99955    | 65715    | 34285    | 00045      | 34330      | 24 |
| 37 | 65947    | 99955    | 65993    | 34007    | 00045      | 34052      | 23 |
| 38 | 66223    | 99954    | 66269    | 33731    | 00046      | 33777      | 22 |
| 39 | 66497    | 99953    | 66543    | 33457    | 00046      | 33503      | 21 |
| 40 | 8.66769  | 9.99953  | 8.66816  | 11.33184 | 10.00047   | 11.33231   | 20 |
| 41 | 67039    | 99952    | 67087    | 32913    | 00048      | 32961      | 19 |
| 42 | 67308    | 99952    | 67356    | 32644    | 00048      | 32692      | 18 |
| 43 | 67575    | 99951    | 67624    | 32376    | 00049      | 32425      | 17 |
| 44 | 67840    | 99951    | 67890    | 32110    | 00049      | 32160      | 16 |
| 45 | 68104    | 99950    | 68154    | 31846    | 00050      | 31896      | 15 |
| 46 | 68366    | 99949    | 68417    | 31583    | 00051      | 31633      | 14 |
| 47 | 68627    | 99949    | 68678    | 31322    | 00051      | 31373      | 13 |
| 48 | 68886    | 99948    | 68938    | 31062    | 00052      | 31114      | 12 |
| 49 | 69144    | 99947    | 69196    | 30804    | 00052      | 30856      | 11 |
| 50 | 8.69400  | 9.99947  | 8.69453  | 11.30547 | 10.00053   | 11.30600   | 10 |
| 51 | 69654    | 99946    | 69708    | 30292    | 00054      | 30346      | 9  |
| 52 | 69907    | 99946    | 69962    | 30038    | 00054      | 30093      | 8  |
| 53 | 70159    | 99945    | 70214    | 29786    | 00055      | 29841      | 7  |
| 54 | 70409    | 99944    | 70465    | 29535    | 00056      | 29591      | 6  |
| 55 | 70658    | 99944    | 70714    | 29286    | 00056      | 29342      | 5  |
| 56 | 70905    | 99943    | 70962    | 29038    | 00057      | 29095      | 4  |
| 57 | 71151    | 99942    | 71208    | 28792    | 00058      | 28849      | 3  |
| 58 | 71395    | 99942    | 71453    | 28546    | 00058      | 28605      | 2  |
| 59 | 71638    | 99941    | 71697    | 28303    | 00059      | 28361      | 1  |
| 60 | 71880    | 99940    | 71940    | 28060    | 00059      | 28120      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 3 Degrees.

| M. | Sine. | Co-sine. | Tangent. | Co-tang. | Secant.  | Co-secant. |          |    |
|----|-------|----------|----------|----------|----------|------------|----------|----|
| 60 | 0     | 8.71880  | 9.99940  | 8.71940  | 11.28060 | 10.00059   | 11.28120 | 60 |
| 59 | 1     | 72120    | 99940    | 72181    | 27819    | 00060      | 27880    | 59 |
| 58 | 2     | 72359    | 99939    | 72420    | 27580    | 00061      | 27640    | 58 |
| 57 | 3     | 72597    | 99938    | 72659    | 27341    | 00062      | 27403    | 57 |
| 56 | 4     | 72834    | 99938    | 72896    | 27104    | 00062      | 27166    | 56 |
| 55 | 5     | 73069    | 99937    | 73132    | 26868    | 00063      | 26931    | 55 |
| 54 | 6     | 73303    | 99936    | 73366    | 26631    | 00064      | 26697    | 54 |
| 53 | 7     | 73535    | 99936    | 73600    | 26400    | 00064      | 26465    | 53 |
| 52 | 8     | 73767    | 99935    | 73832    | 26168    | 00065      | 26233    | 52 |
| 51 | 9     | 73997    | 99934    | 74063    | 25937    | 00065      | 26003    | 51 |
| 50 | 10    | 8.74226  | 9.99934  | 8.74292  | 11.25708 | 10.00066   | 11.25774 | 50 |
| 49 | 11    | 74454    | 99933    | 74521    | 25479    | 00067      | 25546    | 49 |
| 48 | 12    | 74680    | 99932    | 74748    | 25252    | 00068      | 25320    | 48 |
| 47 | 13    | 74905    | 99931    | 74974    | 25026    | 00068      | 25094    | 47 |
| 46 | 14    | 75130    | 99931    | 75199    | 24801    | 00069      | 24870    | 46 |
| 45 | 15    | 75353    | 99930    | 75423    | 24577    | 00070      | 24647    | 45 |
| 44 | 16    | 75575    | 99929    | 75645    | 24355    | 00070      | 24425    | 44 |
| 43 | 17    | 75795    | 99929    | 75867    | 24133    | 00071      | 24204    | 43 |
| 42 | 18    | 76015    | 99928    | 76087    | 23913    | 00072      | 23985    | 42 |
| 41 | 19    | 76234    | 99927    | 76306    | 23693    | 00073      | 23766    | 41 |
| 40 | 20    | 8.76451  | 9.99926  | 8.76525  | 11.23475 | 10.00073   | 11.23549 | 40 |
| 39 | 21    | 76667    | 99926    | 76742    | 23258    | 00074      | 23332    | 39 |
| 38 | 22    | 76883    | 99925    | 76958    | 23042    | 00075      | 23117    | 38 |
| 37 | 23    | 77097    | 99924    | 77173    | 22827    | 00076      | 22903    | 37 |
| 36 | 24    | 77310    | 99923    | 77387    | 22613    | 00076      | 22690    | 36 |
| 35 | 25    | 77522    | 99923    | 77599    | 22400    | 00077      | 22478    | 35 |
| 34 | 26    | 77733    | 99922    | 77811    | 22189    | 00078      | 22267    | 34 |
| 33 | 27    | 77943    | 99921    | 78022    | 21978    | 00079      | 22057    | 33 |
| 32 | 28    | 78152    | 99920    | 78232    | 21768    | 00079      | 21848    | 32 |
| 31 | 29    | 78360    | 99920    | 78441    | 21559    | 00080      | 21639    | 31 |
| 30 | 30    | 8.78567  | 9.99919  | 8.78649  | 11.21351 | 10.00081   | 11.21432 | 30 |
| 29 | 31    | 78774    | 99918    | 78855    | 21145    | 00082      | 21226    | 29 |
| 28 | 32    | 78979    | 99917    | 79061    | 20939    | 00083      | 21021    | 28 |
| 27 | 33    | 79183    | 99917    | 79266    | 20734    | 00083      | 20817    | 27 |
| 26 | 34    | 79386    | 99916    | 79470    | 20530    | 00084      | 20614    | 26 |
| 25 | 35    | 79588    | 99915    | 79673    | 20327    | 00085      | 20412    | 25 |
| 24 | 36    | 79789    | 99914    | 79875    | 20125    | 00086      | 20211    | 24 |
| 23 | 37    | 79990    | 99913    | 80076    | 19924    | 00087      | 20010    | 23 |
| 22 | 38    | 80189    | 99913    | 80276    | 19723    | 00087      | 19811    | 22 |
| 21 | 39    | 80388    | 99912    | 80476    | 19523    | 00088      | 19612    | 21 |
| 20 | 40    | 8.80585  | 9.99911  | 8.80674  | 11.19326 | 10.00089   | 11.19415 | 20 |
| 19 | 41    | 80782    | 99910    | 80872    | 19128    | 00090      | 19218    | 19 |
| 18 | 42    | 80978    | 99909    | 81068    | 18932    | 00091      | 19022    | 18 |
| 17 | 43    | 81173    | 99909    | 81264    | 18736    | 00091      | 18827    | 17 |
| 16 | 44    | 81367    | 99908    | 81459    | 18541    | 00092      | 18633    | 16 |
| 15 | 45    | 81560    | 99907    | 81653    | 18347    | 00093      | 18440    | 15 |
| 14 | 46    | 81752    | 99906    | 81846    | 18154    | 00094      | 18248    | 14 |
| 13 | 47    | 81944    | 99905    | 82038    | 17962    | 00095      | 18056    | 13 |
| 12 | 48    | 82134    | 99904    | 82230    | 17770    | 00096      | 17866    | 12 |
| 11 | 49    | 82324    | 99904    | 82420    | 17579    | 00097      | 17676    | 11 |
| 10 | 50    | 8.82513  | 9.99903  | 8.82610  | 11.17390 | 10.00097   | 11.17487 | 10 |
| 9  | 51    | 82701    | 99902    | 82799    | 17201    | 00098      | 17299    | 9  |
| 8  | 52    | 82888    | 99901    | 82987    | 17013    | 00099      | 17112    | 8  |
| 7  | 53    | 83075    | 99900    | 83175    | 16825    | 00100      | 16925    | 7  |
| 6  | 54    | 83261    | 99899    | 83361    | 16639    | 00101      | 16739    | 6  |
| 5  | 55    | 83446    | 99898    | 83547    | 16453    | 00102      | 16554    | 5  |
| 4  | 56    | 83630    | 99898    | 83732    | 16268    | 00102      | 16370    | 4  |
| 3  | 57    | 83813    | 99897    | 83916    | 16084    | 00103      | 16187    | 3  |
| 2  | 58    | 83996    | 99896    | 84100    | 15900    | 00104      | 16004    | 2  |
| 1  | 59    | 84177    | 99895    | 84282    | 15717    | 00105      | 15823    | 1  |
| 0  | 60    | 84358    | 99894    | 84464    | 15536    | 00106      | 15642    | 0  |
| M. |       | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.  | M. |

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 4 Degree

| M. | Sine.    | Co-line. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 8.84358  | 9.99894  | 8.84464  | 11.15536 | 10.00106   | 11.15642   | 60 |
| 1  | 84539    | 99893    | 84645    | 15355    | 00107      | 15461      | 59 |
| 2  | 84718    | 99892    | 84826    | 15175    | 00108      | 15282      | 58 |
| 3  | 84897    | 99891    | 85006    | 14995    | 00109      | 15103      | 57 |
| 4  | 85075    | 99890    | 85185    | 14814    | 00109      | 14925      | 56 |
| 5  | 85252    | 99890    | 85363    | 14637    | 00110      | 14748      | 55 |
| 6  | 85429    | 99889    | 85540    | 14460    | 00111      | 14571      | 54 |
| 7  | 85605    | 99888    | 85717    | 14283    | 00112      | 14395      | 53 |
| 8  | 85780    | 99887    | 85893    | 14107    | 00113      | 14220      | 52 |
| 9  | 85955    | 99886    | 86069    | 13931    | 00114      | 14045      | 51 |
| 10 | 8.86128  | 9.99885  | 8.86243  | 11.13757 | 10.00115   | 11.13872   | 50 |
| 11 | 86301    | 99884    | 86417    | 13583    | 00116      | 13699      | 49 |
| 12 | 86474    | 99883    | 86590    | 13409    | 00117      | 13526      | 48 |
| 13 | 86645    | 99882    | 86763    | 13237    | 00118      | 13355      | 47 |
| 14 | 86816    | 99881    | 86935    | 13065    | 00119      | 13183      | 46 |
| 15 | 86987    | 99880    | 87106    | 12894    | 00120      | 13013      | 45 |
| 16 | 87156    | 99879    | 87277    | 12723    | 00120      | 12843      | 44 |
| 17 | 87325    | 99878    | 87447    | 12553    | 00121      | 12674      | 43 |
| 18 | 87494    | 99878    | 87616    | 12384    | 00122      | 12506      | 42 |
| 19 | 87661    | 99877    | 87785    | 12215    | 00123      | 12338      | 41 |
| 20 | 8.87829  | 9.99876  | 8.87953  | 11.12047 | 10.00124   | 11.12171   | 40 |
| 21 | 87995    | 99875    | 88120    | 11880    | 00125      | 12005      | 39 |
| 22 | 88161    | 99874    | 88287    | 11713    | 00126      | 11839      | 38 |
| 23 | 88326    | 99873    | 88453    | 11547    | 00127      | 11674      | 37 |
| 24 | 88490    | 99872    | 88618    | 11381    | 00128      | 11510      | 36 |
| 25 | 88654    | 99871    | 88783    | 11217    | 00129      | 11346      | 35 |
| 26 | 88817    | 99870    | 88948    | 11052    | 00130      | 11183      | 34 |
| 27 | 88980    | 99869    | 89111    | 10889    | 00131      | 11020      | 33 |
| 28 | 89142    | 99868    | 89274    | 10726    | 00132      | 10858      | 32 |
| 29 | 89304    | 99867    | 89437    | 10563    | 00133      | 10696      | 31 |
| 30 | 8.89464  | 9.99866  | 8.89598  | 11.10402 | 10.00134   | 11.10536   | 30 |
| 31 | 89624    | 99865    | 89760    | 10240    | 00135      | 10375      | 29 |
| 32 | 89784    | 99864    | 89920    | 10080    | 00136      | 10216      | 28 |
| 33 | 89943    | 99863    | 90080    | 9920     | 00137      | 10057      | 27 |
| 34 | 90102    | 99862    | 90240    | 9760     | 00138      | 99898      | 26 |
| 35 | 90260    | 99861    | 90399    | 9601     | 00139      | 99740      | 25 |
| 36 | 90417    | 99860    | 90557    | 9443     | 00140      | 99583      | 24 |
| 37 | 90574    | 99859    | 90715    | 9285     | 00141      | 99426      | 23 |
| 38 | 90730    | 99858    | 90872    | 9128     | 00142      | 99270      | 22 |
| 39 | 90885    | 99857    | 91028    | 8971     | 00143      | 99115      | 21 |
| 40 | 8.91040  | 9.99856  | 8.91185  | 11.08815 | 10.00144   | 11.08960   | 20 |
| 41 | 91195    | 99855    | 91340    | 8860     | 00145      | 88805      | 19 |
| 42 | 91349    | 99854    | 91495    | 8705     | 00146      | 88651      | 18 |
| 43 | 91502    | 99853    | 91649    | 8550     | 00147      | 88498      | 17 |
| 44 | 91655    | 99852    | 91803    | 8397     | 00148      | 88345      | 16 |
| 45 | 91807    | 99851    | 91957    | 8243     | 00149      | 88193      | 15 |
| 46 | 91959    | 99849    | 92110    | 8090     | 00150      | 88041      | 14 |
| 47 | 92110    | 99848    | 92262    | 7938     | 00151      | 87890      | 13 |
| 48 | 92261    | 99847    | 92414    | 7786     | 00153      | 87739      | 12 |
| 49 | 92411    | 99846    | 92565    | 7635     | 00154      | 87589      | 11 |
| 50 | 8.92561  | 9.99845  | 8.92716  | 11.07284 | 10.00155   | 11.07439   | 10 |
| 51 | 92710    | 99844    | 92866    | 7474     | 00156      | 87290      | 9  |
| 52 | 92859    | 99843    | 93015    | 7314     | 00157      | 87141      | 8  |
| 53 | 93007    | 99842    | 93165    | 7155     | 00158      | 86993      | 7  |
| 54 | 93154    | 99841    | 93313    | 6997     | 00159      | 86846      | 6  |
| 55 | 93301    | 99840    | 93462    | 6838     | 00160      | 86698      | 5  |
| 56 | 93448    | 99839    | 93609    | 6681     | 00161      | 86552      | 4  |
| 57 | 93594    | 99838    | 93756    | 6523     | 00162      | 86406      | 3  |
| 58 | 93740    | 99837    | 93903    | 6367     | 00163      | 86260      | 2  |
| 59 | 93885    | 99835    | 94049    | 6211     | 00164      | 86115      | 1  |
| 60 | 94030    | 99834    | 94195    | 6055     | 00166      | 85970      | 0  |
|    | Co-line. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M  |

85 Degrees.

M m



TABLE V. OF ARTIFICIAL Sines, Tangents, and Secants. 5 Degrees.

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 60 | 8.94030  | 9.99834  | 8.94195  | 11.05805 | 10.00166   | 11.05970   | 60 |
| 59 | 94174    | 99833    | 94340    | 05660    | 00167      | 05826      | 59 |
| 58 | 94317    | 99832    | 94485    | 05515    | 00168      | 05683      | 58 |
| 57 | 94461    | 99831    | 94629    | 05370    | 00169      | 05539      | 57 |
| 56 | 94603    | 99830    | 94773    | 05227    | 00170      | 05397      | 56 |
| 55 | 94746    | 99829    | 94917    | 05083    | 00171      | 05254      | 55 |
| 54 | 94887    | 99828    | 95060    | 04940    | 00172      | 05113      | 54 |
| 53 | 95029    | 99827    | 95202    | 04798    | 00173      | 04971      | 53 |
| 52 | 95170    | 99825    | 95344    | 04656    | 00174      | 04830      | 52 |
| 51 | 95310    | 99824    | 95486    | 04514    | 00175      | 04690      | 51 |
| 50 | 8.95450  | 9.99823  | 8.95627  | 11.04373 | 10.00177   | 11.04550   | 50 |
| 49 | 95590    | 99822    | 95767    | 04233    | 00178      | 04411      | 49 |
| 48 | 95728    | 99821    | 95907    | 04092    | 00179      | 04272      | 48 |
| 47 | 95867    | 99820    | 96047    | 03953    | 00180      | 04133      | 47 |
| 46 | 96005    | 99819    | 96187    | 03813    | 00181      | 03995      | 46 |
| 45 | 96143    | 99817    | 96325    | 03675    | 00183      | 03857      | 45 |
| 44 | 96280    | 99816    | 96464    | 03536    | 00184      | 03720      | 44 |
| 43 | 96417    | 99815    | 96602    | 03398    | 00185      | 03583      | 43 |
| 42 | 96553    | 99814    | 96739    | 03261    | 00186      | 03447      | 42 |
| 41 | 96689    | 99813    | 96877    | 03123    | 00187      | 03311      | 41 |
| 40 | 8.96825  | 9.99812  | 8.97013  | 11.02987 | 10.00188   | 11.03175   | 40 |
| 39 | 96960    | 99810    | 97150    | 02850    | 00190      | 03040      | 39 |
| 38 | 97095    | 99809    | 97285    | 02714    | 00191      | 02905      | 38 |
| 37 | 97229    | 99808    | 97421    | 02579    | 00192      | 02771      | 37 |
| 36 | 97363    | 99807    | 97556    | 02444    | 00193      | 02637      | 36 |
| 35 | 97496    | 99806    | 97691    | 02309    | 00194      | 02504      | 35 |
| 34 | 97629    | 99804    | 97825    | 02175    | 00196      | 02371      | 34 |
| 33 | 97762    | 99803    | 97959    | 02041    | 00197      | 02238      | 33 |
| 32 | 97894    | 99802    | 98092    | 01908    | 00198      | 02106      | 32 |
| 31 | 98026    | 99801    | 98225    | 01775    | 00199      | 01974      | 31 |
| 30 | 8.98157  | 9.99800  | 8.98358  | 11.01642 | 10.00200   | 11.01843   | 30 |
| 29 | 98288    | 99798    | 98490    | 01510    | 00202      | 01712      | 29 |
| 28 | 98419    | 99797    | 98622    | 01378    | 00203      | 01581      | 28 |
| 27 | 98549    | 99796    | 98753    | 01247    | 00204      | 01450      | 27 |
| 26 | 98679    | 99795    | 98884    | 01116    | 00205      | 01321      | 26 |
| 25 | 98808    | 99793    | 99015    | 00985    | 00206      | 01192      | 25 |
| 24 | 98937    | 99792    | 99145    | 00855    | 00208      | 01063      | 24 |
| 23 | 99066    | 99791    | 99275    | 00725    | 00209      | 00934      | 23 |
| 22 | 99194    | 99790    | 99405    | 00595    | 00210      | 00806      | 22 |
| 21 | 99322    | 99788    | 99534    | 00466    | 00211      | 00678      | 21 |
| 20 | 8.99450  | 9.99787  | 8.99662  | 11.00338 | 10.00213   | 11.00550   | 20 |
| 19 | 99577    | 99786    | 99791    | 00209    | 00214      | 00423      | 19 |
| 18 | 99704    | 99785    | 99919    | 00081    | 00215      | 00296      | 18 |
| 17 | 99830    | 99783    | 9.00046  | 10.99954 | 00216      | 00170      | 17 |
| 16 | 99956    | 99782    | 00174    | 99826    | 00218      | 00044      | 16 |
| 15 | 9.00082  | 99781    | 00301    | 99699    | 00219      | 10.99918   | 15 |
| 14 | 00207    | 99780    | 00427    | 99573    | 00220      | 99793      | 14 |
| 13 | 00332    | 99779    | 00553    | 99447    | 00222      | 99668      | 13 |
| 12 | 00456    | 99777    | 00679    | 99321    | 00223      | 99544      | 12 |
| 11 | 00580    | 99776    | 00805    | 99195    | 00224      | 99419      | 11 |
| 10 | 9.00704  | 9.99774  | 9.00930  | 10.99070 | 10.00225   | 10.99296   | 10 |
| 9  | 00828    | 99773    | 01055    | 98945    | 00227      | 99172      | 9  |
| 8  | 00951    | 99772    | 01179    | 98821    | 00228      | 99049      | 8  |
| 7  | 01074    | 99771    | 01303    | 98697    | 00229      | 98926      | 7  |
| 6  | 01196    | 99769    | 01427    | 98573    | 00231      | 98804      | 6  |
| 5  | 01318    | 99768    | 01550    | 98450    | 00232      | 98682      | 5  |
| 4  | 01440    | 99767    | 01673    | 98327    | 00233      | 98560      | 4  |
| 3  | 01561    | 99765    | 01796    | 98204    | 00234      | 98439      | 3  |
| 2  | 01682    | 99764    | 01918    | 98082    | 00236      | 98318      | 2  |
| 1  | 01803    | 99763    | 02040    | 97960    | 00237      | 98197      | 1  |
| 0  | 01923    | 99761    | 02162    | 97838    | 00239      | 98077      | 0  |
| M. | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |

M m

84 Degrees.

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 6 Degrees.

| M. | Sine.    | Co-fine. | Tangent. | Co-tang. | Secant.    | Co-secant. |
|----|----------|----------|----------|----------|------------|------------|
| 0  | 9.01923  | 9.99761  | 9.02162  | 10.97838 | 10.00239   | 10.98076   |
| 1  | 02043    | 99760    | 02283    | 97717    | 00240      | 97996      |
| 2  | 02163    | 99759    | 02404    | 97596    | 00241      | 97837      |
| 3  | 02283    | 99757    | 02525    | 97475    | 00243      | 97717      |
| 4  | 02402    | 99756    | 02645    | 97354    | 00244      | 97598      |
| 5  | 02520    | 99755    | 02765    | 97234    | 00245      | 97480      |
| 6  | 02639    | 99753    | 02885    | 97115    | 00247      | 97361      |
| 7  | 02757    | 99752    | 03005    | 96995    | 00248      | 97243      |
| 8  | 02874    | 99751    | 03124    | 96876    | 00249      | 97126      |
| 9  | 02992    | 99749    | 03242    | 96757    | 00251      | 97008      |
| 10 | 9.03109  | 9.99748  | 9.03361  | 10.96639 | 10.00252   | 10.96891   |
| 11 | 03226    | 99747    | 03479    | 96521    | 00253      | 96774      |
| 12 | 03342    | 99745    | 03597    | 96403    | 00255      | 96658      |
| 13 | 03458    | 99744    | 03714    | 96286    | 00256      | 96542      |
| 14 | 03574    | 99742    | 03832    | 96168    | 00257      | 96426      |
| 15 | 03690    | 99741    | 03948    | 96051    | 00259      | 96310      |
| 16 | 03805    | 99740    | 04065    | 95935    | 00260      | 96195      |
| 17 | 03920    | 99738    | 04181    | 95819    | 00262      | 96080      |
| 18 | 04034    | 99737    | 04297    | 95703    | 00263      | 95966      |
| 19 | 04149    | 99735    | 04413    | 95587    | 00264      | 95851      |
| 20 | 9.04262  | 9.99734  | 9.04528  | 10.95472 | 10.00266   | 10.95737   |
| 21 | 04376    | 99733    | 04643    | 95357    | 00267      | 95624      |
| 22 | 04489    | 99731    | 04758    | 95242    | 00269      | 95510      |
| 23 | 04603    | 99730    | 04873    | 95127    | 00270      | 95397      |
| 24 | 04715    | 99728    | 04987    | 95013    | 00271      | 95285      |
| 25 | 04828    | 99727    | 05101    | 94899    | 00273      | 95172      |
| 26 | 04940    | 99726    | 05214    | 94786    | 00274      | 95060      |
| 27 | 05052    | 99724    | 05328    | 94672    | 00276      | 94948      |
| 28 | 05164    | 99723    | 05441    | 94559    | 00277      | 94836      |
| 29 | 05275    | 99721    | 05553    | 94447    | 00279      | 94725      |
| 30 | 9.05386  | 9.99720  | 9.05666  | 10.94334 | 10.00280   | 10.94614   |
| 31 | 05497    | 99718    | 05778    | 94222    | 00281      | 94503      |
| 32 | 05607    | 99717    | 05890    | 94110    | 00283      | 94393      |
| 33 | 05717    | 99716    | 06002    | 93998    | 00284      | 94283      |
| 34 | 05827    | 99714    | 06113    | 93887    | 00286      | 94173      |
| 35 | 05937    | 99713    | 06224    | 93776    | 00287      | 94063      |
| 36 | 06046    | 99711    | 06335    | 93665    | 00289      | 93954      |
| 37 | 06155    | 99710    | 06445    | 93555    | 00290      | 93845      |
| 38 | 06264    | 99708    | 06556    | 93444    | 00292      | 93736      |
| 39 | 06372    | 99707    | 06665    | 93334    | 00293      | 93628      |
| 40 | 9.06481  | 9.99705  | 9.06775  | 10.93225 | 10.00295   | 10.93519   |
| 41 | 06588    | 99704    | 06885    | 93115    | 00296      | 93411      |
| 42 | 06696    | 99702    | 06994    | 93006    | 00298      | 93304      |
| 43 | 06804    | 99701    | 07103    | 92897    | 00299      | 93196      |
| 44 | 06911    | 99699    | 07211    | 92789    | 00301      | 93089      |
| 45 | 07018    | 99698    | 07320    | 92680    | 00302      | 92982      |
| 46 | 07124    | 99696    | 07428    | 92572    | 00304      | 92876      |
| 47 | 07231    | 99695    | 07536    | 92464    | 00305      | 92769      |
| 48 | 07337    | 99693    | 07643    | 92357    | 00307      | 92663      |
| 49 | 07442    | 99692    | 07750    | 92249    | 00308      | 92558      |
| 50 | 9.07548  | 9.99690  | 9.07858  | 10.92142 | 10.00310   | 10.92452   |
| 51 | 07653    | 99689    | 07964    | 92036    | 00311      | 92347      |
| 52 | 07758    | 99687    | 08071    | 91929    | 00313      | 92242      |
| 53 | 07863    | 99686    | 08177    | 91823    | 00314      | 92137      |
| 54 | 07968    | 99684    | 08283    | 91717    | 00316      | 92032      |
| 55 | 08072    | 99683    | 08389    | 91611    | 00317      | 91928      |
| 56 | 08176    | 99681    | 08495    | 91505    | 00319      | 91824      |
| 57 | 08280    | 99680    | 08601    | 91400    | 00320      | 91720      |
| 58 | 08383    | 99678    | 08705    | 91295    | 00322      | 91617      |
| 59 | 08486    | 99677    | 08810    | 91190    | 00323      | 91514      |
| 60 | 08589    | 99675    | 08914    | 91086    | 00325      | 91411      |
|    | Co-fine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    |

83 Degrees.

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 7 Degrees.

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 9.08589  | 9.99675  | 9.08914  | 10.91086 | 10.00325   | 10.91411   | 66 |
| 1  | 08692    | 99673    | 09019    | 90981    | 00326      | 91308      | 59 |
| 2  | 08795    | 99672    | 09123    | 90877    | 00328      | 91205      | 58 |
| 3  | 08897    | 99670    | 09227    | 90773    | 00330      | 91103      | 57 |
| 4  | 08999    | 99669    | 09330    | 90670    | 00331      | 91001      | 56 |
| 5  | 09101    | 99667    | 09434    | 90566    | 00333      | 90899      | 55 |
| 6  | 09202    | 99666    | 09537    | 90463    | 00334      | 90798      | 54 |
| 7  | 09304    | 99664    | 09640    | 90360    | 00336      | 90696      | 53 |
| 8  | 09405    | 99662    | 09742    | 90258    | 00337      | 90595      | 52 |
| 9  | 09506    | 99661    | 09845    | 90155    | 00339      | 90494      | 51 |
| 10 | 9.09606  | 9.99659  | 9.09947  | 10.90053 | 10.00341   | 10.90394   | 50 |
| 11 | 09706    | 99658    | 10049    | 89951    | 00342      | 90293      | 49 |
| 12 | 09807    | 99656    | 10150    | 89850    | 00344      | 90193      | 48 |
| 13 | 09906    | 99655    | 10252    | 89748    | 00345      | 90093      | 47 |
| 14 | 10006    | 99653    | 10353    | 89647    | 00347      | 89994      | 46 |
| 15 | 10106    | 99651    | 10454    | 89546    | 00349      | 89894      | 45 |
| 16 | 10205    | 99650    | 10555    | 89445    | 00350      | 89795      | 44 |
| 17 | 10304    | 99648    | 10656    | 89344    | 00352      | 89696      | 43 |
| 18 | 10402    | 99647    | 10756    | 89244    | 00353      | 89597      | 42 |
| 19 | 10501    | 99645    | 10856    | 89144    | 00355      | 89499      | 41 |
| 20 | 9.10599  | 9.99643  | 9.10956  | 10.89044 | 10.00357   | 10.89401   | 40 |
| 21 | 10697    | 99642    | 11056    | 88944    | 00358      | 89303      | 39 |
| 22 | 10795    | 99640    | 11155    | 88845    | 00360      | 89205      | 38 |
| 23 | 10893    | 99638    | 11254    | 88746    | 00362      | 89107      | 37 |
| 24 | 10990    | 99637    | 11353    | 88647    | 00363      | 89010      | 36 |
| 25 | 11087    | 99635    | 11452    | 88548    | 00365      | 88913      | 35 |
| 26 | 11184    | 99633    | 11551    | 88449    | 00366      | 88816      | 34 |
| 27 | 11281    | 99632    | 11649    | 88351    | 00368      | 88719      | 33 |
| 28 | 11377    | 99630    | 11747    | 88253    | 00370      | 88623      | 32 |
| 29 | 11474    | 99628    | 11845    | 88155    | 00371      | 88526      | 31 |
| 30 | 9.11570  | 9.99627  | 9.11943  | 10.88057 | 10.00373   | 10.88430   | 30 |
| 31 | 11666    | 99625    | 12040    | 87960    | 00375      | 88334      | 29 |
| 32 | 11761    | 99623    | 12138    | 87862    | 00376      | 88239      | 28 |
| 33 | 11857    | 99622    | 12235    | 87763    | 00378      | 88143      | 27 |
| 34 | 11952    | 99620    | 12332    | 87668    | 00380      | 88048      | 26 |
| 35 | 12047    | 99618    | 12428    | 87572    | 00381      | 87953      | 25 |
| 36 | 12142    | 99617    | 12525    | 87475    | 00383      | 87858      | 24 |
| 37 | 12236    | 99615    | 12621    | 87379    | 00385      | 87764      | 23 |
| 38 | 12331    | 99613    | 12717    | 87283    | 00387      | 87669      | 22 |
| 39 | 12425    | 99611    | 12813    | 87187    | 00388      | 87575      | 21 |
| 40 | 9.12519  | 9.99610  | 9.12909  | 10.87091 | 10.00390   | 10.87481   | 20 |
| 41 | 12612    | 99608    | 13004    | 86996    | 00392      | 87387      | 19 |
| 42 | 12706    | 99607    | 13099    | 86901    | 00393      | 87294      | 18 |
| 43 | 12799    | 99605    | 13194    | 86806    | 00395      | 87201      | 17 |
| 44 | 12892    | 99603    | 13289    | 86711    | 00397      | 87107      | 16 |
| 45 | 12985    | 99601    | 13384    | 86616    | 00398      | 86015      | 15 |
| 46 | 13078    | 99600    | 13478    | 86522    | 00400      | 86922      | 14 |
| 47 | 13171    | 99598    | 13573    | 86427    | 00402      | 86829      | 13 |
| 48 | 13263    | 99596    | 13667    | 86333    | 00404      | 86737      | 12 |
| 49 | 13355    | 99595    | 13760    | 86239    | 00405      | 86645      | 11 |
| 50 | 9.13447  | 9.99593  | 9.13854  | 10.86146 | 10.00407   | 10.86553   | 10 |
| 51 | 13539    | 99591    | 13948    | 86052    | 00409      | 86461      | 9  |
| 52 | 13630    | 99589    | 14041    | 85959    | 00411      | 86370      | 8  |
| 53 | 13722    | 99588    | 14134    | 85866    | 00412      | 86278      | 7  |
| 54 | 13813    | 99586    | 14227    | 85773    | 00414      | 86187      | 6  |
| 55 | 13904    | 99584    | 14320    | 85680    | 00416      | 86096      | 5  |
| 56 | 13994    | 99582    | 14412    | 85588    | 00418      | 86006      | 4  |
| 57 | 14085    | 99581    | 14504    | 85496    | 00419      | 85915      | 3  |
| 58 | 14175    | 99579    | 14596    | 85403    | 00421      | 85825      | 2  |
| 59 | 14266    | 99577    | 14688    | 85311    | 00423      | 85734      | 1  |
| 60 | 14356    | 99575    | 14780    | 85200    | 00425      | 85644      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |



TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 8 Degree

| M. | Sine.    | Co-sine. | Tangent. | Co-tang.  | Secant.    | Co-secant. |    |
|----|----------|----------|----------|-----------|------------|------------|----|
| 0  | 9. 14356 | 9. 99575 | 9. 14780 | 10. 85220 | 10. 00425  | 10. 85644  | 60 |
| 1  | 14445    | 99573    | 14872    | 85128     | 00426      | 85555      | 59 |
| 2  | 14535    | 99572    | 14963    | 85037     | 00428      | 85465      | 58 |
| 3  | 14624    | 99570    | 15054    | 84946     | 00430      | 85376      | 57 |
| 4  | 14714    | 99568    | 15145    | 84855     | 00432      | 85286      | 56 |
| 5  | 14803    | 99566    | 15236    | 84764     | 00434      | 85197      | 55 |
| 6  | 14891    | 99565    | 15327    | 84673     | 00435      | 85108      | 54 |
| 7  | 14980    | 99563    | 15417    | 84583     | 00437      | 85020      | 53 |
| 8  | 15069    | 99561    | 15508    | 84492     | 00439      | 84931      | 52 |
| 9  | 15157    | 99559    | 15598    | 84402     | 00441      | 84843      | 51 |
| 10 | 9. 15245 | 9. 99557 | 9. 15688 | 10. 84312 | 10. 00443  | 10. 84755  | 50 |
| 11 | 15333    | 99555    | 15777    | 84222     | 00444      | 84667      | 49 |
| 12 | 15421    | 99554    | 15867    | 84133     | 00446      | 84579      | 48 |
| 13 | 15508    | 99552    | 15956    | 84043     | 00448      | 84492      | 47 |
| 14 | 15596    | 99550    | 16046    | 83954     | 00450      | 84404      | 46 |
| 15 | 15683    | 99548    | 16135    | 83865     | 00452      | 84317      | 45 |
| 16 | 15770    | 99546    | 16224    | 83776     | 00454      | 84230      | 44 |
| 17 | 15857    | 99545    | 16312    | 83688     | 00455      | 84143      | 43 |
| 18 | 15943    | 99543    | 16401    | 83599     | 00457      | 84056      | 42 |
| 19 | 16030    | 99541    | 16489    | 83511     | 00459      | 83970      | 41 |
| 20 | 9. 16116 | 9. 99539 | 9. 16577 | 10. 83423 | 10. 00461  | 10. 83884  | 40 |
| 21 | 16203    | 99537    | 16665    | 83335     | 00463      | 83797      | 39 |
| 22 | 16289    | 99535    | 16753    | 83247     | 00465      | 83711      | 38 |
| 23 | 16374    | 99533    | 16841    | 83159     | 00467      | 83626      | 37 |
| 24 | 16460    | 99532    | 16928    | 83072     | 00468      | 83540      | 36 |
| 25 | 16545    | 99530    | 17016    | 82984     | 00470      | 83455      | 35 |
| 26 | 16631    | 99528    | 17103    | 82897     | 00472      | 83369      | 34 |
| 27 | 16716    | 99526    | 17190    | 82810     | 00474      | 83284      | 33 |
| 28 | 16801    | 99524    | 17277    | 82723     | 00476      | 83199      | 32 |
| 29 | 16886    | 99522    | 17363    | 82637     | 00478      | 83114      | 31 |
| 30 | 9. 16970 | 9. 99520 | 9. 17450 | 10. 82550 | 10. 00480  | 10. 83030  | 30 |
| 31 | 17055    | 99518    | 17536    | 82464     | 00482      | 82945      | 29 |
| 32 | 17139    | 99517    | 17622    | 82378     | 00483      | 82861      | 28 |
| 33 | 17223    | 99515    | 17708    | 82292     | 00485      | 82777      | 27 |
| 34 | 17307    | 99513    | 17794    | 82206     | 00487      | 82693      | 26 |
| 35 | 17391    | 99511    | 17880    | 82120     | 00489      | 82609      | 25 |
| 36 | 17474    | 99509    | 17965    | 82034     | 00491      | 82526      | 24 |
| 37 | 17558    | 99507    | 18051    | 81949     | 00493      | 82442      | 23 |
| 38 | 17641    | 99505    | 18136    | 81864     | 00495      | 82359      | 22 |
| 39 | 17724    | 99503    | 18221    | 81779     | 00497      | 82276      | 21 |
| 40 | 9. 17807 | 9. 99501 | 9. 18306 | 10. 81694 | 10. 00499  | 10. 82193  | 20 |
| 41 | 17890    | 99499    | 18391    | 81609     | 00501      | 82110      | 19 |
| 42 | 17973    | 99497    | 18475    | 81525     | 00503      | 82027      | 18 |
| 43 | 18055    | 99495    | 18560    | 81440     | 00504      | 81945      | 17 |
| 44 | 18137    | 99493    | 18644    | 81356     | 00506      | 81863      | 16 |
| 45 | 18220    | 99492    | 18728    | 81272     | 00508      | 81780      | 15 |
| 46 | 18302    | 99490    | 18812    | 81188     | 00510      | 81698      | 14 |
| 47 | 18383    | 99488    | 18896    | 81104     | 00512      | 81617      | 13 |
| 48 | 18465    | 99486    | 18979    | 81021     | 00514      | 81535      | 12 |
| 49 | 18547    | 99484    | 19063    | 80937     | 00516      | 81453      | 11 |
| 50 | 9. 18628 | 9. 99482 | 9. 19146 | 10. 80854 | 10. 00518  | 10. 81372  | 10 |
| 51 | 18709    | 99480    | 19229    | 80771     | 00520      | 81291      | 9  |
| 52 | 18790    | 99478    | 19312    | 80688     | 00522      | 81210      | 8  |
| 53 | 18871    | 99476    | 19395    | 80605     | 00524      | 81129      | 7  |
| 54 | 18952    | 99474    | 19478    | 80522     | 00526      | 81048      | 6  |
| 55 | 19033    | 99472    | 19561    | 80436     | 00528      | 80967      | 5  |
| 56 | 19113    | 99470    | 19643    | 80357     | 00530      | 80887      | 4  |
| 57 | 19193    | 99468    | 19725    | 80275     | 00532      | 80807      | 3  |
| 58 | 19273    | 99466    | 19807    | 80193     | 00534      | 80727      | 2  |
| 59 | 19353    | 99464    | 19889    | 80111     | 00536      | 80647      | 1  |
| 60 | 19433    | 99462    | 19971    | 80029     | 00538      | 80567      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    | M. |

81 Degrees.

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 9 Degrees.

| M. | Sine.    | Co-sine. | Tangent. | Co-tang.  | Secant.    | Co-secant. |    |
|----|----------|----------|----------|-----------|------------|------------|----|
| 60 | 9. 19433 | 9. 99462 | 9. 19971 | 10. 80029 | 10. 00538  | 10. 80567  | 60 |
| 59 | 19513    | 99460    | 20053    | 79947     | 00540      | 80487      | 59 |
| 58 | 19592    | 99458    | 20134    | 79865     | 00542      | 80408      | 58 |
| 57 | 19672    | 99456    | 20216    | 79784     | 00544      | 80328      | 57 |
| 56 | 19751    | 99454    | 20297    | 79703     | 00546      | 80249      | 56 |
| 55 | 19830    | 99452    | 20378    | 79621     | 00548      | 80170      | 55 |
| 54 | 19909    | 99450    | 20459    | 79541     | 00550      | 80091      | 54 |
| 53 | 19988    | 99448    | 20540    | 79460     | 00552      | 80012      | 53 |
| 52 | 20067    | 99446    | 20621    | 79379     | 00554      | 79933      | 52 |
| 51 | 20145    | 99444    | 20701    | 79299     | 00556      | 79855      | 51 |
| 50 | 9. 20223 | 9. 99442 | 9. 20782 | 10. 79218 | 10. 00558  | 10. 79777  | 50 |
| 49 | 20302    | 99440    | 20862    | 79138     | 00560      | 79698      | 49 |
| 48 | 20380    | 99438    | 20942    | 79058     | 00562      | 79620      | 48 |
| 47 | 20458    | 99436    | 21022    | 78978     | 00564      | 79542      | 47 |
| 46 | 20535    | 99434    | 21102    | 78898     | 00566      | 79465      | 46 |
| 45 | 20613    | 99432    | 21181    | 78818     | 00568      | 79387      | 45 |
| 44 | 20691    | 99429    | 21261    | 78739     | 00570      | 79309      | 44 |
| 43 | 20768    | 99427    | 21340    | 78659     | 00573      | 79232      | 43 |
| 42 | 20845    | 99425    | 21420    | 78580     | 00575      | 79155      | 42 |
| 41 | 20922    | 99423    | 21499    | 78501     | 00577      | 79078      | 41 |
| 40 | 9. 20999 | 9. 99421 | 9. 21578 | 10. 78422 | 10. 00579  | 10. 79001  | 40 |
| 39 | 21076    | 99419    | 21657    | 78343     | 00581      | 78924      | 39 |
| 38 | 21153    | 99417    | 21736    | 78264     | 00583      | 78847      | 38 |
| 37 | 21229    | 99415    | 21814    | 78186     | 00585      | 78771      | 37 |
| 36 | 21305    | 99413    | 21893    | 78107     | 00587      | 78694      | 36 |
| 35 | 21382    | 99411    | 21971    | 78029     | 00589      | 78618      | 35 |
| 34 | 21458    | 99409    | 22049    | 77951     | 00591      | 78542      | 34 |
| 33 | 21534    | 99407    | 22127    | 77873     | 00593      | 78465      | 33 |
| 32 | 21610    | 99404    | 22205    | 77795     | 00595      | 78390      | 32 |
| 31 | 21665    | 99402    | 22283    | 77717     | 00598      | 78315      | 31 |
| 30 | 9. 21761 | 9. 99400 | 9. 22361 | 10. 77639 | 10. 00600  | 10. 78239  | 30 |
| 29 | 21836    | 99398    | 22438    | 77562     | 00602      | 78164      | 29 |
| 28 | 21912    | 99396    | 22516    | 77484     | 00604      | 78088      | 28 |
| 27 | 21987    | 99394    | 22593    | 77407     | 00606      | 78013      | 27 |
| 26 | 22062    | 99392    | 22670    | 77330     | 00608      | 77938      | 26 |
| 25 | 22137    | 99390    | 22747    | 77253     | 00610      | 77863      | 25 |
| 24 | 22211    | 99388    | 22824    | 77177     | 00612      | 77788      | 24 |
| 23 | 22286    | 99385    | 22901    | 77099     | 00615      | 77714      | 23 |
| 22 | 22361    | 99383    | 22977    | 77022     | 00617      | 77639      | 22 |
| 21 | 22435    | 99381    | 23054    | 76946     | 00619      | 77565      | 21 |
| 20 | 9. 22509 | 9. 99379 | 9. 23130 | 10. 76870 | 10. 00621  | 10. 77491  | 20 |
| 19 | 22583    | 99377    | 23206    | 76793     | 00623      | 77417      | 19 |
| 18 | 22657    | 99375    | 23283    | 76717     | 00625      | 77343      | 18 |
| 17 | 22731    | 99372    | 23355    | 76641     | 00628      | 77269      | 17 |
| 16 | 22805    | 99370    | 23435    | 76565     | 00630      | 77195      | 16 |
| 15 | 22878    | 99368    | 23510    | 76490     | 00632      | 77122      | 15 |
| 14 | 22952    | 99366    | 23586    | 76414     | 00634      | 77048      | 14 |
| 13 | 23025    | 99364    | 23661    | 76339     | 00636      | 76975      | 13 |
| 12 | 23098    | 99362    | 23737    | 76263     | 00638      | 76902      | 12 |
| 11 | 23171    | 99359    | 23812    | 76188     | 00641      | 76829      | 11 |
| 10 | 9. 23244 | 9. 99357 | 9. 23887 | 10. 76113 | 10. 00643  | 10. 76756  | 10 |
| 9  | 23317    | 99355    | 23962    | 76038     | 00645      | 76683      | 9  |
| 8  | 23390    | 99353    | 24037    | 75963     | 00647      | 76610      | 8  |
| 7  | 23462    | 99351    | 24112    | 75888     | 00649      | 76538      | 7  |
| 6  | 23535    | 99348    | 24186    | 75813     | 00652      | 76465      | 6  |
| 5  | 23607    | 99346    | 24261    | 75739     | 00654      | 76393      | 5  |
| 4  | 23679    | 99344    | 24335    | 75665     | 00656      | 76321      | 4  |
| 3  | 23751    | 99342    | 24410    | 75590     | 00658      | 76248      | 3  |
| 2  | 23823    | 99340    | 24484    | 75516     | 00660      | 76177      | 2  |
| 1  | 23895    | 99337    | 24558    | 75442     | 00663      | 76105      | 1  |
| 0  | 23967    | 99335    | 24633    | 75368     | 00665      | 76033      | 0  |
| M. | Co-sine. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    | M. |

80 Degrees.

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 10 Degree

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 9.23967  | 9.99335  | 9.24632  | 10.75368 | 10.00665   | 10.76033   | 60 |
| 1  | 24039    | 99333    | 24706    | 75294    | 00667      | 75961      | 59 |
| 2  | 24110    | 99331    | 24779    | 75221    | 00669      | 75890      | 58 |
| 3  | 24181    | 99328    | 24853    | 75147    | 00672      | 75819      | 57 |
| 4  | 24253    | 99326    | 24926    | 75074    | 00674      | 75747      | 56 |
| 5  | 24324    | 99324    | 25000    | 75000    | 00676      | 75676      | 55 |
| 6  | 24395    | 99322    | 25073    | 74927    | 00678      | 75605      | 54 |
| 7  | 24466    | 99319    | 25146    | 74854    | 00680      | 75534      | 53 |
| 8  | 24536    | 99317    | 25219    | 74781    | 00683      | 75464      | 52 |
| 9  | 24607    | 99315    | 25292    | 74708    | 00685      | 75393      | 51 |
| 10 | 9.24677  | 9.99313  | 9.25365  | 10.74635 | 10.00687   | 10.75323   | 50 |
| 11 | 24748    | 99310    | 25437    | 74563    | 00690      | 75252      | 49 |
| 12 | 24818    | 99308    | 25510    | 74490    | 00692      | 75182      | 48 |
| 13 | 24888    | 99306    | 25582    | 74418    | 00694      | 75112      | 47 |
| 14 | 24958    | 99304    | 25655    | 74345    | 00696      | 75042      | 46 |
| 15 | 25028    | 99301    | 25727    | 74273    | 00699      | 74972      | 45 |
| 16 | 25098    | 99299    | 25799    | 74201    | 00701      | 74902      | 44 |
| 17 | 25168    | 99297    | 25871    | 74129    | 00703      | 74832      | 43 |
| 18 | 25237    | 99294    | 25943    | 74057    | 00706      | 74762      | 42 |
| 19 | 25307    | 99292    | 26015    | 73985    | 00708      | 74693      | 41 |
| 20 | 9.25376  | 9.99290  | 9.26086  | 10.73914 | 10.00710   | 10.74623   | 40 |
| 21 | 25445    | 99288    | 26158    | 73842    | 00712      | 74555      | 39 |
| 22 | 25514    | 99285    | 26229    | 73771    | 00715      | 74486      | 38 |
| 23 | 25583    | 99283    | 26301    | 73699    | 00717      | 74417      | 37 |
| 24 | 25652    | 99281    | 26372    | 73628    | 00719      | 74348      | 36 |
| 25 | 25721    | 99278    | 26443    | 73557    | 00722      | 74279      | 35 |
| 26 | 25790    | 99276    | 26514    | 73486    | 00724      | 74210      | 34 |
| 27 | 25858    | 99274    | 26585    | 73415    | 00726      | 74142      | 33 |
| 28 | 25927    | 99271    | 26655    | 73344    | 00729      | 74073      | 32 |
| 29 | 25995    | 99269    | 26726    | 73274    | 00731      | 74005      | 31 |
| 30 | 9.26063  | 9.99267  | 9.26797  | 10.73203 | 10.00733   | 10.73937   | 30 |
| 31 | 26131    | 99264    | 26867    | 73133    | 00736      | 73869      | 29 |
| 32 | 26199    | 99262    | 26937    | 73063    | 00738      | 73801      | 28 |
| 33 | 26267    | 99260    | 27008    | 72992    | 00741      | 73733      | 27 |
| 34 | 26335    | 99257    | 27078    | 72922    | 00743      | 73665      | 26 |
| 35 | 26403    | 99255    | 27148    | 72852    | 00745      | 73597      | 25 |
| 36 | 26470    | 99252    | 27218    | 72782    | 00747      | 73530      | 24 |
| 37 | 26538    | 99250    | 27288    | 72712    | 00750      | 73462      | 23 |
| 38 | 26605    | 99248    | 27357    | 72643    | 00752      | 73395      | 22 |
| 39 | 26672    | 99245    | 27427    | 72573    | 00755      | 73328      | 21 |
| 40 | 9.26739  | 9.99243  | 9.27496  | 10.72594 | 10.00757   | 10.73261   | 20 |
| 41 | 26806    | 99241    | 27566    | 72434    | 00759      | 73193      | 19 |
| 42 | 26873    | 99238    | 27635    | 72365    | 00762      | 73127      | 18 |
| 43 | 26940    | 99236    | 27704    | 72296    | 00764      | 73060      | 17 |
| 44 | 27007    | 99233    | 27773    | 72227    | 00766      | 72993      | 16 |
| 45 | 27073    | 99231    | 27842    | 72158    | 00769      | 72927      | 15 |
| 46 | 27140    | 99229    | 27911    | 72089    | 00771      | 72860      | 14 |
| 47 | 27206    | 99226    | 27980    | 72020    | 00774      | 72794      | 13 |
| 48 | 27273    | 99224    | 28049    | 71951    | 00776      | 72727      | 12 |
| 49 | 27339    | 99221    | 28117    | 71883    | 00779      | 72661      | 11 |
| 50 | 9.27405  | 9.99219  | 9.28186  | 10.71814 | 10.00781   | 10.72595   | 10 |
| 51 | 27471    | 99217    | 28254    | 71746    | 00783      | 72529      | 9  |
| 52 | 27537    | 99214    | 28323    | 71677    | 00786      | 72463      | 8  |
| 53 | 27602    | 99212    | 28391    | 71609    | 00788      | 72398      | 7  |
| 54 | 27668    | 99209    | 28459    | 71541    | 00791      | 72332      | 6  |
| 55 | 27734    | 99207    | 28527    | 71473    | 00793      | 72266      | 5  |
| 56 | 27799    | 99204    | 28595    | 71405    | 00796      | 72201      | 4  |
| 57 | 27864    | 99202    | 28662    | 71338    | 00798      | 72136      | 3  |
| 58 | 27930    | 99200    | 28730    | 71270    | 00800      | 72070      | 2  |
| 59 | 27995    | 99197    | 28798    | 71202    | 00803      | 72005      | 1  |
| 60 | 28060    | 99195    | 28865    | 71135    | 00805      | 72940      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |



TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 11 Degrees.

| M. | Sine.    | Co-sine. | Tangent. | Co-tang.  | Secant.    | Co-secant. |    |
|----|----------|----------|----------|-----------|------------|------------|----|
| 60 | 9. 28060 | 9. 99195 | 9. 28865 | 10. 71135 | 10. 00865  | 10. 71940  | 60 |
| 59 | 28125    | 99192    | 28933    | 71067     | 00808      | 71875      | 59 |
| 58 | 28190    | 99190    | 29000    | 71000     | 00810      | 71810      | 58 |
| 57 | 28254    | 99187    | 29067    | 70933     | 00813      | 71746      | 57 |
| 56 | 28319    | 99185    | 29134    | 70866     | 00815      | 71681      | 56 |
| 55 | 28384    | 99182    | 29201    | 70799     | 00818      | 71616      | 55 |
| 54 | 28448    | 99180    | 29268    | 70732     | 00820      | 71552      | 54 |
| 53 | 28512    | 99177    | 29335    | 70665     | 00823      | 71488      | 53 |
| 52 | 28577    | 99175    | 29402    | 70598     | 00825      | 71423      | 52 |
| 51 | 28641    | 99172    | 29468    | 70532     | 00828      | 71359      | 51 |
| 50 | 9. 28705 | 9. 99170 | 9. 29535 | 10. 70465 | 10. 00830  | 10. 71295  | 50 |
| 49 | 28769    | 99167    | 29601    | 70399     | 00833      | 71231      | 49 |
| 48 | 28833    | 99165    | 29668    | 70332     | 00835      | 71167      | 48 |
| 47 | 28896    | 99162    | 29734    | 70266     | 00838      | 71104      | 47 |
| 46 | 28960    | 99160    | 29800    | 70200     | 00840      | 71040      | 46 |
| 45 | 29024    | 99157    | 29866    | 70134     | 00843      | 70975      | 45 |
| 44 | 29087    | 99155    | 29932    | 70068     | 00845      | 70913      | 44 |
| 43 | 29150    | 99152    | 29998    | 70002     | 00848      | 70850      | 43 |
| 42 | 29214    | 99150    | 30064    | 69936     | 00850      | 70786      | 42 |
| 41 | 29277    | 99147    | 30130    | 69870     | 00853      | 70723      | 41 |
| 40 | 9. 29340 | 9. 99145 | 9. 30195 | 10. 69805 | 10. 00855  | 10. 70660  | 40 |
| 39 | 29403    | 99142    | 30261    | 69739     | 00858      | 70597      | 39 |
| 38 | 29466    | 99140    | 30326    | 69674     | 00860      | 70534      | 38 |
| 37 | 29529    | 99137    | 30391    | 69609     | 00863      | 70471      | 37 |
| 36 | 29591    | 99135    | 30457    | 69543     | 00865      | 70409      | 36 |
| 35 | 29654    | 99132    | 30522    | 69478     | 00868      | 70346      | 35 |
| 34 | 29716    | 99130    | 30587    | 69413     | 00870      | 70284      | 34 |
| 33 | 29779    | 99127    | 30652    | 69348     | 00873      | 70221      | 33 |
| 32 | 29841    | 99124    | 30717    | 69283     | 00876      | 70159      | 32 |
| 31 | 29903    | 99122    | 30782    | 69218     | 00878      | 70097      | 31 |
| 30 | 9. 29966 | 9. 99119 | 9. 30846 | 10. 69154 | 10. 00881  | 10. 70034  | 30 |
| 29 | 30028    | 99117    | 30911    | 69089     | 00883      | 69972      | 29 |
| 28 | 30090    | 99114    | 30975    | 69025     | 00886      | 69910      | 28 |
| 27 | 30151    | 99112    | 31040    | 68960     | 00888      | 69849      | 27 |
| 26 | 30213    | 99109    | 31104    | 68896     | 00891      | 69787      | 26 |
| 25 | 30275    | 99106    | 31168    | 68831     | 00894      | 69725      | 25 |
| 24 | 30336    | 99104    | 31233    | 68767     | 00896      | 69664      | 24 |
| 23 | 30398    | 99101    | 31297    | 68703     | 00899      | 69602      | 23 |
| 22 | 30459    | 99099    | 31361    | 68639     | 00901      | 69541      | 22 |
| 21 | 30521    | 99096    | 31424    | 68575     | 00904      | 69479      | 21 |
| 20 | 9. 30582 | 9. 99093 | 9. 31489 | 10. 68511 | 10. 00907  | 10. 69418  | 20 |
| 19 | 30643    | 99091    | 31552    | 68448     | 00909      | 69357      | 19 |
| 18 | 30704    | 99088    | 31616    | 68384     | 00912      | 69296      | 18 |
| 17 | 30765    | 99086    | 31679    | 68320     | 00914      | 69235      | 17 |
| 16 | 30826    | 99083    | 31743    | 68257     | 00917      | 69174      | 16 |
| 15 | 30887    | 99080    | 31806    | 68194     | 00920      | 69113      | 15 |
| 14 | 30947    | 99078    | 31870    | 68130     | 00922      | 69053      | 14 |
| 13 | 31008    | 99075    | 31933    | 68067     | 00925      | 68992      | 13 |
| 12 | 31068    | 99072    | 31996    | 68004     | 00928      | 68931      | 12 |
| 11 | 31129    | 99070    | 32059    | 67941     | 00930      | 68871      | 11 |
| 10 | 9. 31189 | 9. 99067 | 9. 32122 | 10. 67878 | 10. 00933  | 10. 68811  | 10 |
| 9  | 31249    | 99064    | 32185    | 67815     | 00936      | 68750      | 9  |
| 8  | 31310    | 99062    | 32148    | 67752     | 00938      | 68690      | 8  |
| 7  | 31370    | 99059    | 32311    | 67689     | 00941      | 68630      | 7  |
| 6  | 31430    | 99056    | 32373    | 67627     | 00944      | 68570      | 6  |
| 5  | 31490    | 99054    | 32436    | 67564     | 00946      | 68510      | 5  |
| 4  | 31549    | 99051    | 32498    | 67502     | 00949      | 68451      | 4  |
| 3  | 31609    | 99048    | 32561    | 67439     | 00952      | 68391      | 3  |
| 2  | 31669    | 99046    | 32623    | 67377     | 00954      | 68331      | 2  |
| 1  | 31728    | 99043    | 32685    | 67315     | 00957      | 68272      | 1  |
| 0  | 31788    | 99040    | 32747    | 67252     | 00960      | 68212      | 0  |
| M. | Co-sine. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    | M. |

78 Degrees.

TABLE V. OF ARTIFICIAL Sines, Tangents, and Secants. 72 Degrees.

| M. | Sine.    | Co-line. | Tangent. | Co-tang.  | Secant.    | Co-secant. |    |
|----|----------|----------|----------|-----------|------------|------------|----|
| 0  | 9. 31788 | 9. 99040 | 9. 32747 | 10. 67253 | 10. 00960  | 10. 68212  | 60 |
| 1  | 31847    | 99038    | 32810    | 67190     | 00962      | 68153      | 59 |
| 2  | 31907    | 99035    | 32872    | 67128     | 00965      | 68093      | 58 |
| 3  | 31966    | 99032    | 32933    | 67067     | 00968      | 68034      | 57 |
| 4  | 32025    | 99030    | 32995    | 67005     | 00970      | 67975      | 56 |
| 5  | 32084    | 99027    | 33057    | 66943     | 00973      | 67916      | 55 |
| 6  | 32143    | 99024    | 33119    | 66881     | 00976      | 67857      | 54 |
| 7  | 32202    | 99022    | 33180    | 66820     | 00978      | 67798      | 53 |
| 8  | 32261    | 99019    | 33242    | 66758     | 00981      | 67739      | 52 |
| 9  | 32319    | 99016    | 33303    | 66697     | 00984      | 67681      | 51 |
| 10 | 9. 32378 | 9. 99013 | 9. 33365 | 10. 66635 | 10. 00987  | 10. 67622  | 50 |
| 11 | 32437    | 99011    | 33426    | 66574     | 00989      | 67563      | 49 |
| 12 | 32495    | 99008    | 33487    | 66513     | 00992      | 67505      | 48 |
| 13 | 32553    | 99005    | 33548    | 66452     | 00995      | 67447      | 47 |
| 14 | 32612    | 99002    | 33609    | 66391     | 00998      | 67388      | 46 |
| 15 | 32670    | 99000    | 33670    | 66330     | 01000      | 67330      | 45 |
| 16 | 32728    | 98997    | 33731    | 66269     | 01003      | 67272      | 44 |
| 17 | 32786    | 98994    | 33792    | 66208     | 01006      | 67214      | 43 |
| 18 | 32844    | 98991    | 33853    | 66147     | 01009      | 67156      | 42 |
| 19 | 32902    | 98989    | 33913    | 66087     | 01011      | 67098      | 41 |
| 20 | 9. 32960 | 9. 98986 | 9. 33974 | 10. 66026 | 10. 01014  | 10. 67040  | 40 |
| 21 | 33018    | 98983    | 34034    | 65966     | 01017      | 66982      | 39 |
| 22 | 33075    | 98980    | 34095    | 65905     | 01020      | 66925      | 38 |
| 23 | 33133    | 98978    | 34155    | 65845     | 01022      | 66867      | 37 |
| 24 | 33190    | 98975    | 34215    | 65784     | 01025      | 66810      | 36 |
| 25 | 33248    | 98972    | 34276    | 65724     | 01028      | 66752      | 35 |
| 26 | 33305    | 98969    | 34336    | 65664     | 01031      | 66695      | 34 |
| 27 | 33362    | 98967    | 34396    | 65604     | 01033      | 66638      | 33 |
| 28 | 33420    | 98964    | 34456    | 65544     | 01036      | 66580      | 32 |
| 29 | 33477    | 98961    | 34516    | 65484     | 01039      | 66523      | 31 |
| 30 | 9. 33534 | 9. 98958 | 9. 34576 | 10. 65424 | 10. 01042  | 10. 66466  | 30 |
| 31 | 33591    | 98955    | 34635    | 65365     | 01045      | 66409      | 29 |
| 32 | 33647    | 98953    | 34695    | 65305     | 01047      | 66352      | 28 |
| 33 | 33704    | 98950    | 34755    | 65245     | 01050      | 66296      | 27 |
| 34 | 33761    | 98947    | 34814    | 65186     | 01053      | 66239      | 26 |
| 35 | 33818    | 98944    | 34874    | 65126     | 01056      | 66182      | 25 |
| 36 | 33874    | 98941    | 34933    | 65067     | 01059      | 66126      | 24 |
| 37 | 33931    | 98938    | 34992    | 65008     | 01062      | 66069      | 23 |
| 38 | 33987    | 98936    | 35051    | 64949     | 01064      | 66013      | 22 |
| 39 | 34043    | 98933    | 35111    | 64889     | 01067      | 65957      | 21 |
| 40 | 9. 34100 | 9. 98930 | 9. 35170 | 10. 64830 | 10. 01070  | 10. 65900  | 20 |
| 41 | 34156    | 98927    | 35229    | 64771     | 01073      | 65844      | 19 |
| 42 | 34212    | 98924    | 35288    | 64712     | 01076      | 65788      | 18 |
| 43 | 34268    | 98921    | 35346    | 64653     | 01079      | 65732      | 17 |
| 44 | 34324    | 98919    | 35405    | 64595     | 01081      | 65676      | 16 |
| 45 | 34380    | 98916    | 35464    | 64536     | 01084      | 65620      | 15 |
| 46 | 34435    | 98913    | 35523    | 64478     | 01087      | 65564      | 14 |
| 47 | 34491    | 98910    | 35581    | 64419     | 01090      | 65509      | 13 |
| 48 | 34547    | 98907    | 35640    | 64360     | 01093      | 65453      | 12 |
| 49 | 34602    | 98904    | 35698    | 64302     | 01096      | 65398      | 11 |
| 50 | 9. 34658 | 9. 98901 | 9. 35757 | 10. 64243 | 10. 01099  | 10. 65342  | 10 |
| 51 | 34713    | 98898    | 35815    | 64185     | 01102      | 65287      | 9  |
| 52 | 34769    | 98896    | 35873    | 64127     | 01104      | 65231      | 8  |
| 53 | 34824    | 98893    | 35931    | 64069     | 01107      | 65176      | 7  |
| 54 | 34879    | 98890    | 35989    | 64011     | 01110      | 65121      | 6  |
| 55 | 34934    | 98887    | 36047    | 63953     | 01113      | 65066      | 5  |
| 56 | 34989    | 98884    | 36105    | 63895     | 01116      | 65011      | 4  |
| 57 | 35044    | 98881    | 36163    | 63837     | 01119      | 64956      | 3  |
| 58 | 35099    | 98878    | 36221    | 63779     | 01122      | 64901      | 2  |
| 59 | 35154    | 98875    | 36279    | 63721     | 01125      | 64846      | 1  |
| 60 | 35209    | 98872    | 36336    | 63664     | 01128      | 64791      | 0  |
|    | Co-line. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    | M. |

77 Degrees.

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 13 Degrees.

|    | M. | Sine.    | Co-sine. | Tangent. | Co-tang.  | Secant.    | Co-secant. |    |
|----|----|----------|----------|----------|-----------|------------|------------|----|
| 60 | 0  | 9. 35209 | 9. 98872 | 9. 36336 | 10. 63664 | 10. 01128  | 10. 64791  | 60 |
| 59 | 1  | 35263    | 98869    | 36394    | 63606     | 01130      | 64736      | 59 |
| 58 | 2  | 35318    | 98867    | 36451    | 63548     | 01133      | 64682      | 58 |
| 57 | 3  | 35373    | 98864    | 36509    | 63491     | 01136      | 64627      | 57 |
| 56 | 4  | 35427    | 98861    | 36566    | 63434     | 01139      | 64573      | 56 |
| 55 | 5  | 35481    | 98858    | 36624    | 63376     | 01142      | 64518      | 55 |
| 54 | 6  | 35536    | 98855    | 36681    | 63319     | 01145      | 64464      | 54 |
| 53 | 7  | 35590    | 98852    | 36738    | 63262     | 01148      | 64410      | 53 |
| 52 | 8  | 35644    | 98849    | 36795    | 63205     | 01151      | 64356      | 52 |
| 51 | 9  | 35698    | 98846    | 36852    | 63148     | 01154      | 64302      | 51 |
| 50 | 10 | 9. 35752 | 9. 98843 | 9. 36909 | 10. 63091 | 10. 01157  | 10. 64248  | 50 |
| 49 | 11 | 35806    | 98840    | 36966    | 63034     | 01160      | 64194      | 49 |
| 48 | 12 | 35860    | 98837    | 37023    | 62977     | 01163      | 64140      | 48 |
| 47 | 13 | 35914    | 98834    | 37080    | 62920     | 01166      | 64086      | 47 |
| 46 | 14 | 35968    | 98831    | 37137    | 62863     | 01169      | 64032      | 46 |
| 45 | 15 | 36021    | 98828    | 37193    | 62807     | 01172      | 63978      | 45 |
| 44 | 16 | 36075    | 98825    | 37250    | 62750     | 01175      | 63925      | 44 |
| 43 | 17 | 36129    | 98822    | 37306    | 62694     | 01178      | 63871      | 43 |
| 42 | 18 | 36182    | 98819    | 37363    | 62637     | 01181      | 63818      | 42 |
| 41 | 19 | 36236    | 98816    | 37419    | 62581     | 01184      | 63764      | 41 |
| 40 | 20 | 9. 36289 | 9. 98813 | 9. 37476 | 10. 62524 | 10. 01187  | 10. 63711  | 40 |
| 39 | 21 | 36342    | 98810    | 37532    | 62468     | 01190      | 63658      | 39 |
| 38 | 22 | 36395    | 98807    | 37588    | 62412     | 01193      | 63605      | 38 |
| 37 | 23 | 36448    | 98804    | 37644    | 62356     | 01196      | 63551      | 37 |
| 36 | 24 | 36502    | 98801    | 37700    | 62300     | 01199      | 63498      | 36 |
| 35 | 25 | 36555    | 98798    | 37756    | 62244     | 01202      | 63445      | 35 |
| 34 | 26 | 36607    | 98795    | 37812    | 62188     | 01205      | 63392      | 34 |
| 33 | 27 | 36660    | 98792    | 37868    | 62132     | 01208      | 63340      | 33 |
| 32 | 28 | 36713    | 98789    | 37924    | 62076     | 01211      | 63287      | 32 |
| 31 | 29 | 36766    | 98786    | 37980    | 62020     | 01214      | 63234      | 31 |
| 30 | 30 | 9. 36818 | 9. 98783 | 9. 38035 | 10. 61965 | 10. 01217  | 10. 63181  | 30 |
| 29 | 31 | 36871    | 98780    | 38091    | 61909     | 01220      | 63129      | 29 |
| 28 | 32 | 36924    | 98777    | 38147    | 61853     | 01223      | 63076      | 28 |
| 27 | 33 | 36976    | 98774    | 38202    | 61798     | 01226      | 63024      | 27 |
| 26 | 34 | 37028    | 98771    | 38257    | 61743     | 01229      | 62971      | 26 |
| 25 | 35 | 37081    | 98768    | 38313    | 61687     | 01232      | 62919      | 25 |
| 24 | 36 | 37133    | 98765    | 38368    | 61632     | 01235      | 62867      | 24 |
| 23 | 37 | 37185    | 98762    | 38423    | 61577     | 01238      | 62815      | 23 |
| 22 | 38 | 37237    | 98759    | 38479    | 61521     | 01241      | 62763      | 22 |
| 21 | 39 | 37289    | 98756    | 38534    | 61466     | 01244      | 62711      | 21 |
| 20 | 40 | 9. 37341 | 9. 98753 | 9. 38589 | 10. 61411 | 10. 01247  | 10. 62659  | 20 |
| 19 | 41 | 37393    | 98749    | 38644    | 61356     | 01250      | 62607      | 19 |
| 18 | 42 | 37445    | 98746    | 38699    | 61301     | 01254      | 62555      | 18 |
| 17 | 43 | 37497    | 98743    | 38754    | 61246     | 01257      | 62503      | 17 |
| 16 | 44 | 37549    | 98740    | 38808    | 61192     | 01260      | 62451      | 16 |
| 15 | 45 | 37600    | 98737    | 38863    | 61137     | 01263      | 62400      | 15 |
| 14 | 46 | 37652    | 98734    | 38918    | 61082     | 01266      | 62348      | 14 |
| 13 | 47 | 37703    | 98731    | 38972    | 61028     | 01269      | 62296      | 13 |
| 12 | 48 | 37755    | 98728    | 39027    | 60973     | 01272      | 62245      | 12 |
| 11 | 49 | 37806    | 98725    | 39081    | 60918     | 01275      | 62194      | 11 |
| 10 | 50 | 9. 37858 | 9. 98722 | 9. 39136 | 10. 60864 | 10. 01278  | 10. 62142  | 10 |
| 9  | 51 | 37909    | 98719    | 39190    | 60810     | 01281      | 62091      | 9  |
| 8  | 52 | 37960    | 98715    | 39245    | 60755     | 01285      | 62040      | 8  |
| 7  | 53 | 38011    | 98712    | 39299    | 60701     | 01288      | 61989      | 7  |
| 6  | 54 | 38062    | 98709    | 39353    | 60647     | 01291      | 61938      | 6  |
| 5  | 55 | 38113    | 98706    | 39407    | 60593     | 01294      | 61887      | 5  |
| 4  | 56 | 38164    | 98703    | 39461    | 60539     | 01297      | 61836      | 4  |
| 3  | 57 | 38215    | 98700    | 39515    | 60485     | 01300      | 61785      | 3  |
| 2  | 58 | 38266    | 98697    | 39569    | 60431     | 01303      | 61734      | 2  |
| 1  | 59 | 38317    | 98694    | 39623    | 60377     | 01306      | 61683      | 1  |
| 0  | 60 | 38368    | 98690    | 39677    | 60323     | 01310      | 61632      | 0  |
| M. |    | Co-sine. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    | M. |



TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 14 Degr etc

| M. | Sine.    | Co-fine. | Tangent. | Co-tang.  | Secant.    | Co-secant. |    |
|----|----------|----------|----------|-----------|------------|------------|----|
| 0  | 9. 38368 | 9. 98690 | 9. 39677 | 10. 60323 | 10. 01310  | 10. 61632  | 60 |
| 1  | 38418    | 98687    | 39731    | 60269     | 01313      | 61582      | 59 |
| 2  | 38469    | 98684    | 39785    | 60215     | 01316      | 61531      | 58 |
| 3  | 38519    | 98681    | 39838    | 60162     | 01319      | 61481      | 57 |
| 4  | 38570    | 98678    | 39892    | 60108     | 01322      | 61430      | 56 |
| 5  | 38620    | 98675    | 39945    | 60054     | 01325      | 61380      | 55 |
| 6  | 38670    | 98672    | 39999    | 60001     | 01329      | 61330      | 54 |
| 7  | 38721    | 98668    | 40052    | 59948     | 01332      | 61280      | 53 |
| 8  | 38771    | 98665    | 40106    | 59894     | 01335      | 61229      | 52 |
| 9  | 38821    | 98662    | 40159    | 59841     | 01338      | 61179      | 51 |
| 10 | 9. 38871 | 9. 98659 | 9. 40212 | 10. 59788 | 10. 01341  | 10. 61129  | 50 |
| 11 | 38921    | 98655    | 40266    | 59734     | 01344      | 61079      | 49 |
| 12 | 38971    | 98652    | 40319    | 59681     | 01348      | 61029      | 48 |
| 13 | 39021    | 98649    | 40372    | 59628     | 01351      | 60979      | 47 |
| 14 | 39071    | 98646    | 40425    | 59575     | 01354      | 60929      | 46 |
| 15 | 39121    | 98643    | 40478    | 59522     | 01357      | 60879      | 45 |
| 16 | 39170    | 98640    | 40531    | 59469     | 01360      | 60830      | 44 |
| 17 | 39220    | 98636    | 40584    | 59416     | 01364      | 60780      | 43 |
| 18 | 39270    | 98633    | 40636    | 59363     | 01367      | 60730      | 42 |
| 19 | 39319    | 98630    | 40689    | 59311     | 01370      | 60681      | 41 |
| 20 | 9. 39369 | 9. 98627 | 9. 40742 | 10. 59258 | 10. 01373  | 10. 60631  | 40 |
| 21 | 39418    | 98623    | 40795    | 59205     | 01377      | 60582      | 39 |
| 22 | 39467    | 98620    | 40847    | 59153     | 01380      | 60533      | 38 |
| 23 | 39517    | 98617    | 40900    | 59100     | 01383      | 60483      | 37 |
| 24 | 39566    | 98614    | 40952    | 59048     | 01386      | 60434      | 36 |
| 25 | 39615    | 98610    | 41004    | 58995     | 01390      | 60385      | 35 |
| 26 | 39664    | 98607    | 41057    | 58943     | 01393      | 60336      | 34 |
| 27 | 39713    | 98604    | 41109    | 58891     | 01396      | 60287      | 33 |
| 28 | 39762    | 98601    | 41161    | 58839     | 01399      | 60238      | 32 |
| 29 | 39811    | 98597    | 41214    | 58786     | 01403      | 60189      | 31 |
| 30 | 9. 39860 | 9. 98594 | 9. 41266 | 10. 58734 | 10. 01406  | 10. 60140  | 30 |
| 31 | 39909    | 98591    | 41318    | 58682     | 01409      | 60091      | 29 |
| 32 | 39957    | 98588    | 41370    | 58630     | 01412      | 60042      | 28 |
| 33 | 40006    | 98584    | 41422    | 58578     | 01416      | 59994      | 27 |
| 34 | 40055    | 98581    | 41474    | 58526     | 01419      | 59945      | 26 |
| 35 | 40103    | 98578    | 41526    | 58474     | 01422      | 59896      | 25 |
| 36 | 40152    | 98574    | 41577    | 58422     | 01426      | 59848      | 24 |
| 37 | 40200    | 98571    | 41629    | 58371     | 01429      | 59800      | 23 |
| 38 | 40249    | 98568    | 41681    | 58319     | 01432      | 59751      | 22 |
| 39 | 40297    | 98565    | 41733    | 58267     | 01435      | 59703      | 21 |
| 40 | 9. 40345 | 9. 98561 | 9. 41784 | 10. 58216 | 10. 01439  | 10. 59654  | 20 |
| 41 | 40394    | 98558    | 41836    | 58164     | 01442      | 59606      | 19 |
| 42 | 40442    | 98555    | 41887    | 58113     | 01445      | 59558      | 18 |
| 43 | 40490    | 98551    | 41939    | 58061     | 01449      | 59510      | 17 |
| 44 | 40538    | 98548    | 41990    | 58010     | 01452      | 59462      | 16 |
| 45 | 40586    | 98545    | 42041    | 57958     | 01455      | 59414      | 15 |
| 46 | 40634    | 98541    | 42093    | 57907     | 01459      | 59366      | 14 |
| 47 | 40682    | 98538    | 42144    | 57856     | 01462      | 59318      | 13 |
| 48 | 40730    | 98535    | 42195    | 57805     | 01465      | 59270      | 12 |
| 49 | 40778    | 98531    | 42246    | 57754     | 01469      | 59222      | 11 |
| 50 | 9. 40825 | 9. 98528 | 9. 42297 | 10. 57703 | 10. 01472  | 10. 59175  | 10 |
| 51 | 40873    | 98525    | 42348    | 57652     | 01475      | 59127      | 9  |
| 52 | 40921    | 98521    | 42399    | 57601     | 01479      | 59079      | 8  |
| 53 | 40968    | 98518    | 42450    | 57550     | 01482      | 59032      | 7  |
| 54 | 41016    | 98515    | 42501    | 57499     | 01485      | 58984      | 6  |
| 55 | 41063    | 98511    | 42552    | 57448     | 01489      | 58937      | 5  |
| 56 | 41111    | 98508    | 42603    | 57397     | 01492      | 58889      | 4  |
| 57 | 41158    | 98504    | 42653    | 57347     | 01495      | 58842      | 3  |
| 58 | 41205    | 98501    | 42704    | 57296     | 01499      | 58795      | 2  |
| 59 | 41252    | 98498    | 42755    | 57245     | 01502      | 58748      | 1  |
| 60 | 41300    | 98494    | 42805    | 57195     | 01506      | 58700      | 0  |
|    | Co-fine. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    |    |

75 Degrees.

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 15 Degrees.

| M.       | Sine. | Co-sine. | Tangent. | Co-tang.   | Secant.   | Co-secant. |    |
|----------|-------|----------|----------|------------|-----------|------------|----|
| 60       | 0     | 9. 41300 | 9. 98494 | 9. 42805   | 10. 57195 | 10. 01506  | 60 |
| 59       | 1     | 41347    | 98491    | 42856      | 57144     | 01509      | 59 |
| 58       | 2     | 41394    | 98488    | 42906      | 57094     | 01512      | 58 |
| 57       | 3     | 41441    | 98484    | 42957      | 57043     | 01516      | 57 |
| 56       | 4     | 41488    | 98481    | 43007      | 56993     | 01519      | 56 |
| 55       | 5     | 41535    | 98477    | 43057      | 56943     | 01523      | 55 |
| 54       | 6     | 41582    | 98474    | 43108      | 56893     | 01526      | 54 |
| 53       | 7     | 41628    | 98471    | 43158      | 56843     | 01529      | 53 |
| 52       | 8     | 41675    | 98467    | 43208      | 56793     | 01533      | 52 |
| 51       | 9     | 41722    | 98464    | 43258      | 56743     | 01536      | 51 |
| 50       | 10    | 9. 41768 | 9. 98460 | 9. 43308   | 10. 56692 | 10. 01540  | 50 |
| 49       | 11    | 41815    | 98457    | 43358      | 56642     | 01543      | 49 |
| 48       | 12    | 41861    | 98453    | 43408      | 56592     | 01547      | 48 |
| 47       | 13    | 41908    | 98450    | 43458      | 56542     | 01550      | 47 |
| 46       | 14    | 41954    | 98447    | 43508      | 56492     | 01553      | 46 |
| 45       | 15    | 42001    | 98443    | 43558      | 56442     | 01557      | 45 |
| 44       | 16    | 42047    | 98440    | 43607      | 56393     | 01560      | 44 |
| 43       | 17    | 42093    | 98436    | 43657      | 56343     | 01564      | 43 |
| 42       | 18    | 42139    | 98433    | 43707      | 56293     | 01567      | 42 |
| 41       | 19    | 42186    | 98429    | 43756      | 56244     | 01571      | 41 |
| 40       | 20    | 9. 42232 | 9. 98426 | 9. 43806   | 10. 56194 | 10. 01574  | 40 |
| 39       | 21    | 42278    | 98422    | 43855      | 56145     | 01578      | 39 |
| 38       | 22    | 42324    | 98419    | 43905      | 56095     | 01581      | 38 |
| 37       | 23    | 42370    | 98415    | 43954      | 56046     | 01584      | 37 |
| 36       | 24    | 42416    | 98412    | 44004      | 55996     | 01588      | 36 |
| 35       | 25    | 42461    | 98409    | 44053      | 55947     | 01591      | 35 |
| 34       | 26    | 42507    | 98405    | 44102      | 55898     | 01595      | 34 |
| 33       | 27    | 42553    | 98402    | 44151      | 55848     | 01598      | 33 |
| 32       | 28    | 42599    | 98398    | 44201      | 55799     | 01602      | 32 |
| 31       | 29    | 42644    | 98395    | 44250      | 55750     | 01605      | 31 |
| 30       | 30    | 9. 42690 | 9. 98391 | 9. 44299   | 10. 55701 | 10. 01609  | 30 |
| 29       | 31    | 42735    | 98388    | 44348      | 55652     | 01612      | 29 |
| 28       | 32    | 42781    | 98384    | 44397      | 55603     | 01616      | 28 |
| 27       | 33    | 42826    | 98381    | 44446      | 55554     | 01619      | 27 |
| 26       | 34    | 42872    | 98377    | 44495      | 55505     | 01623      | 26 |
| 25       | 35    | 42917    | 98373    | 44544      | 55456     | 01626      | 25 |
| 24       | 36    | 42962    | 98370    | 44592      | 55408     | 01630      | 24 |
| 23       | 37    | 43007    | 98366    | 44641      | 55359     | 01634      | 23 |
| 22       | 38    | 43053    | 98363    | 44690      | 55310     | 01637      | 22 |
| 21       | 39    | 43098    | 98359    | 44738      | 55262     | 01641      | 21 |
| 20       | 40    | 9. 43143 | 9. 98356 | 9. 44787   | 10. 55213 | 10. 01644  | 20 |
| 19       | 41    | 43188    | 98352    | 44836      | 55164     | 01648      | 19 |
| 18       | 42    | 43233    | 98349    | 44884      | 55116     | 01651      | 18 |
| 17       | 43    | 43278    | 98345    | 44933      | 55067     | 01655      | 17 |
| 16       | 44    | 43323    | 98342    | 44981      | 55019     | 01658      | 16 |
| 15       | 45    | 43367    | 98338    | 45029      | 54971     | 01662      | 15 |
| 14       | 46    | 43412    | 98334    | 45078      | 54922     | 01666      | 14 |
| 13       | 47    | 43457    | 98331    | 45126      | 54874     | 01669      | 13 |
| 12       | 48    | 43502    | 98327    | 45174      | 54826     | 01673      | 12 |
| 11       | 49    | 43546    | 98324    | 45222      | 54778     | 01676      | 11 |
| 10       | 50    | 9. 43591 | 9. 98320 | 9. 45271   | 10. 54729 | 10. 01680  | 10 |
| 9        | 51    | 43635    | 98317    | 45319      | 54681     | 01683      | 9  |
| 8        | 52    | 43680    | 98313    | 45367      | 54633     | 01687      | 8  |
| 7        | 53    | 43724    | 98309    | 45415      | 54585     | 01691      | 7  |
| 6        | 54    | 43769    | 98306    | 45463      | 54537     | 01694      | 6  |
| 5        | 55    | 43813    | 98302    | 45511      | 54489     | 01698      | 5  |
| 4        | 56    | 43857    | 98299    | 45559      | 54441     | 01701      | 4  |
| 3        | 57    | 43901    | 98295    | 45606      | 54394     | 01705      | 3  |
| 2        | 58    | 43946    | 98291    | 45654      | 54346     | 01709      | 2  |
| 1        | 59    | 43990    | 98288    | 45702      | 54298     | 01712      | 1  |
| 0        | 60    | 44034    | 98284    | 45750      | 54250     | 01716      | 0  |
| Co-sine. | Sine. | Co-tang. | Tangent. | Co-secant. | Secant.   | M.         |    |

TABLE V. OF ARTIFICIAL Sines, Tangents, and Secants. 16 Degrees

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 9.44034  | 9.98284  | 9.45750  | 10.54250 | 10.01716   | 10.55966   | 60 |
| 1  | 44078    | 98281    | 45797    | 54203    | 01719      | 55922      | 59 |
| 2  | 44122    | 98277    | 45845    | 54155    | 01723      | 55878      | 58 |
| 3  | 44166    | 98273    | 45892    | 54108    | 01727      | 55834      | 57 |
| 4  | 44210    | 98270    | 45940    | 54060    | 01730      | 55790      | 56 |
| 5  | 44253    | 98266    | 45987    | 54013    | 01734      | 55746      | 55 |
| 6  | 44297    | 98262    | 46035    | 53965    | 01738      | 55703      | 54 |
| 7  | 44341    | 98259    | 46082    | 53918    | 01741      | 55659      | 53 |
| 8  | 44385    | 98255    | 46130    | 53870    | 01745      | 55615      | 52 |
| 9  | 44428    | 98251    | 46177    | 53823    | 01749      | 55572      | 51 |
| 10 | 9.44472  | 9.98248  | 9.46224  | 10.53776 | 10.01752   | 10.55528   | 50 |
| 11 | 44515    | 98244    | 46271    | 53728    | 01756      | 55484      | 49 |
| 12 | 44559    | 98240    | 46319    | 53681    | 01760      | 55441      | 48 |
| 13 | 44602    | 98237    | 46366    | 53634    | 01763      | 55397      | 47 |
| 14 | 44646    | 98233    | 46413    | 53587    | 01767      | 55354      | 46 |
| 15 | 44689    | 98229    | 46460    | 53540    | 01771      | 55311      | 45 |
| 16 | 44733    | 98226    | 46507    | 53493    | 01774      | 55267      | 44 |
| 17 | 44776    | 98222    | 46554    | 53446    | 01778      | 55224      | 43 |
| 18 | 44819    | 98218    | 46601    | 53399    | 01782      | 55181      | 42 |
| 19 | 44862    | 98215    | 46648    | 53352    | 01785      | 55138      | 41 |
| 20 | 9.44905  | 9.98211  | 9.46694  | 10.53306 | 10.01789   | 10.55095   | 40 |
| 21 | 44948    | 98207    | 46741    | 53259    | 01793      | 55051      | 39 |
| 22 | 44991    | 98203    | 46788    | 53212    | 01796      | 55008      | 38 |
| 23 | 45035    | 98200    | 46835    | 53165    | 01800      | 54965      | 37 |
| 24 | 45077    | 98196    | 46881    | 53119    | 01804      | 54923      | 36 |
| 25 | 45120    | 98192    | 46928    | 53072    | 01808      | 54880      | 35 |
| 26 | 45163    | 98189    | 46975    | 53025    | 01811      | 54837      | 34 |
| 27 | 45206    | 98185    | 47021    | 52979    | 01815      | 54794      | 33 |
| 28 | 45249    | 98181    | 47068    | 52932    | 01819      | 54751      | 32 |
| 29 | 45292    | 98177    | 47114    | 52886    | 01823      | 54708      | 31 |
| 30 | 9.45334  | 9.98174  | 9.47160  | 10.52840 | 10.01826   | 10.54666   | 30 |
| 31 | 45377    | 98170    | 47207    | 52793    | 01830      | 54624      | 29 |
| 32 | 45419    | 98166    | 47253    | 52747    | 01834      | 54581      | 28 |
| 33 | 45462    | 98162    | 47299    | 52701    | 01838      | 54538      | 27 |
| 34 | 45504    | 98159    | 47346    | 52654    | 01841      | 54496      | 26 |
| 35 | 45547    | 98155    | 47392    | 52608    | 01845      | 54453      | 25 |
| 36 | 45589    | 98151    | 47438    | 52562    | 01849      | 54411      | 24 |
| 37 | 45632    | 98147    | 47484    | 52516    | 01853      | 54368      | 23 |
| 38 | 45674    | 98144    | 47530    | 52470    | 01856      | 54326      | 22 |
| 39 | 45716    | 98140    | 47576    | 52424    | 01860      | 54284      | 21 |
| 40 | 9.45758  | 9.98136  | 9.47622  | 10.52378 | 10.01864   | 10.53242   | 20 |
| 41 | 45801    | 98132    | 47668    | 52332    | 01868      | 53199      | 19 |
| 42 | 45843    | 98128    | 47714    | 52286    | 01871      | 53157      | 18 |
| 43 | 45885    | 98125    | 47760    | 52240    | 01875      | 53115      | 17 |
| 44 | 45927    | 98121    | 47806    | 52194    | 01879      | 53073      | 16 |
| 45 | 45969    | 98117    | 47852    | 52148    | 01883      | 53031      | 15 |
| 46 | 46011    | 98113    | 47897    | 52102    | 01887      | 52989      | 14 |
| 47 | 46053    | 98109    | 47943    | 52057    | 01890      | 52947      | 13 |
| 48 | 46095    | 98106    | 47989    | 52011    | 01894      | 52905      | 12 |
| 49 | 46136    | 98102    | 48034    | 51965    | 01898      | 52864      | 11 |
| 50 | 9.46178  | 9.98098  | 9.48080  | 10.51920 | 10.01902   | 10.53822   | 10 |
| 51 | 46220    | 98094    | 48126    | 51874    | 01906      | 53780      | 9  |
| 52 | 46262    | 98090    | 48171    | 51829    | 01910      | 53738      | 8  |
| 53 | 46303    | 98087    | 48217    | 51783    | 01913      | 53697      | 7  |
| 54 | 46345    | 98083    | 48262    | 51738    | 01917      | 53655      | 6  |
| 55 | 46386    | 98079    | 48307    | 51692    | 01921      | 53614      | 5  |
| 56 | 46428    | 98075    | 48353    | 51647    | 01925      | 53572      | 4  |
| 57 | 46469    | 98071    | 48398    | 51602    | 01929      | 53531      | 3  |
| 58 | 46511    | 98067    | 48443    | 51557    | 01933      | 53489      | 2  |
| 59 | 46552    | 98063    | 48489    | 51511    | 01937      | 53448      | 1  |
| 60 | 46594    | 98060    | 48534    | 51466    | 01940      | 53406      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    |    |



TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 17 Degrees.

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 9.46593  | 9.98060  | 9.48534  | 10.51466 | 10.01940   | 10.53406   | 60 |
| 1  | 46635    | 98056    | 48579    | 51421    | 01944      | 53365      | 59 |
| 2  | 46676    | 98052    | 48624    | 51376    | 01948      | 53324      | 58 |
| 3  | 46717    | 98048    | 48669    | 51331    | 01952      | 53283      | 57 |
| 4  | 46758    | 98044    | 48714    | 51286    | 01956      | 53241      | 56 |
| 5  | 46800    | 98040    | 48759    | 51241    | 01960      | 53200      | 55 |
| 6  | 46841    | 98036    | 48804    | 51196    | 01964      | 53159      | 54 |
| 7  | 46882    | 98032    | 48849    | 51151    | 01968      | 53118      | 53 |
| 8  | 46923    | 98029    | 48894    | 51106    | 01971      | 53077      | 52 |
| 9  | 46964    | 98025    | 48939    | 51061    | 01975      | 53036      | 51 |
| 10 | 9.47005  | 9.98021  | 9.48984  | 10.51016 | 10.01979   | 10.52995   | 50 |
| 11 | 47045    | 98017    | 49029    | 50971    | 01983      | 52954      | 49 |
| 12 | 47086    | 98013    | 49073    | 50927    | 01987      | 52914      | 48 |
| 13 | 47127    | 98009    | 49118    | 50882    | 01991      | 52873      | 47 |
| 14 | 47168    | 98005    | 49163    | 50837    | 01995      | 52832      | 46 |
| 15 | 47209    | 98001    | 49207    | 50793    | 01999      | 52791      | 45 |
| 16 | 47249    | 97997    | 49252    | 50748    | 02003      | 52751      | 44 |
| 17 | 47290    | 97993    | 49296    | 50703    | 02007      | 52710      | 43 |
| 18 | 47330    | 97989    | 49341    | 50659    | 02010      | 52670      | 42 |
| 19 | 47371    | 97986    | 49385    | 50614    | 02014      | 52629      | 41 |
| 20 | 9.47411  | 9.97982  | 9.49430  | 10.50570 | 10.02018   | 10.52588   | 40 |
| 21 | 47452    | 97978    | 49474    | 50526    | 02022      | 52548      | 39 |
| 22 | 47492    | 97974    | 49519    | 50481    | 02026      | 52508      | 38 |
| 23 | 47533    | 97970    | 49563    | 50437    | 02030      | 52467      | 37 |
| 24 | 47573    | 97966    | 49607    | 50393    | 02034      | 52427      | 36 |
| 25 | 47613    | 97962    | 49651    | 50348    | 02038      | 52387      | 35 |
| 26 | 47654    | 97958    | 49696    | 50304    | 02042      | 52346      | 34 |
| 27 | 47694    | 97954    | 49740    | 50260    | 02046      | 52306      | 33 |
| 28 | 47734    | 97950    | 49784    | 50216    | 02050      | 52266      | 32 |
| 29 | 47774    | 97946    | 49828    | 50172    | 02054      | 52226      | 31 |
| 30 | 9.47814  | 9.97942  | 9.49872  | 10.50128 | 10.02058   | 10.52186   | 30 |
| 31 | 47854    | 97938    | 49916    | 50084    | 02062      | 52146      | 29 |
| 32 | 47894    | 97934    | 49960    | 50040    | 02066      | 52106      | 28 |
| 33 | 47934    | 97930    | 50004    | 49996    | 02070      | 52066      | 27 |
| 34 | 47974    | 97926    | 50048    | 49952    | 02074      | 52026      | 26 |
| 35 | 48014    | 97922    | 50092    | 49908    | 02078      | 51986      | 25 |
| 36 | 48054    | 97918    | 50136    | 49864    | 02082      | 51946      | 24 |
| 37 | 48094    | 97914    | 50180    | 49820    | 02086      | 51906      | 23 |
| 38 | 48133    | 97910    | 50223    | 49776    | 02090      | 51867      | 22 |
| 39 | 48173    | 97906    | 50267    | 49733    | 02094      | 51827      | 21 |
| 40 | 9.48213  | 9.97902  | 9.50311  | 10.49689 | 10.02098   | 10.51787   | 20 |
| 41 | 48252    | 97898    | 50355    | 49645    | 02102      | 51747      | 19 |
| 42 | 48292    | 97894    | 50398    | 49602    | 02106      | 51708      | 18 |
| 43 | 48332    | 97890    | 50442    | 49558    | 02110      | 51668      | 17 |
| 44 | 48371    | 97886    | 50485    | 49515    | 02114      | 51629      | 16 |
| 45 | 48411    | 97882    | 50529    | 49471    | 02118      | 51589      | 15 |
| 46 | 48450    | 97878    | 50572    | 49428    | 02122      | 51550      | 14 |
| 47 | 48489    | 97874    | 50616    | 49384    | 02126      | 51510      | 13 |
| 48 | 48529    | 97870    | 50659    | 49341    | 02130      | 51471      | 12 |
| 49 | 48568    | 97866    | 50703    | 49297    | 02134      | 51432      | 11 |
| 50 | 9.48607  | 9.97861  | 9.50746  | 10.49254 | 10.02139   | 10.51392   | 10 |
| 51 | 48647    | 97857    | 50789    | 49211    | 02143      | 51353      | 9  |
| 52 | 48686    | 97853    | 50833    | 49167    | 02147      | 51314      | 8  |
| 53 | 48725    | 97849    | 50876    | 49124    | 02151      | 51275      | 7  |
| 54 | 48764    | 97845    | 50919    | 49081    | 02155      | 51236      | 6  |
| 55 | 48803    | 97841    | 50962    | 49038    | 02159      | 51197      | 5  |
| 56 | 48842    | 97837    | 51005    | 48995    | 02163      | 51158      | 4  |
| 57 | 48881    | 97833    | 51048    | 48951    | 02167      | 51119      | 3  |
| 58 | 48920    | 97829    | 51092    | 48908    | 02171      | 51080      | 2  |
| 59 | 48959    | 97825    | 51135    | 48865    | 02175      | 51041      | 1  |
| 60 | 48998    | 97821    | 51178    | 48822    | 02179      | 51002      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M  |

72 Degrees.

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 18 Degree

| M. | Sine.    | Co-sine. | Tangent. | Co-tang.  | Secant.    | Co-secant. |    |
|----|----------|----------|----------|-----------|------------|------------|----|
| 0  | 9. 48998 | 9. 97821 | 9. 51178 | 10. 48822 | 10. 02179  | 10. 51002  | 60 |
| 1  | 49037    | 97817    | 51221    | 48779     | 02183      | 50963      | 59 |
| 2  | 49076    | 97812    | 51264    | 48736     | 02188      | 50924      | 58 |
| 3  | 49115    | 97808    | 51306    | 48694     | 02192      | 50885      | 57 |
| 4  | 49153    | 97804    | 51349    | 48651     | 02196      | 50847      | 56 |
| 5  | 49192    | 97800    | 51392    | 48608     | 02200      | 50808      | 55 |
| 6  | 49231    | 97796    | 51435    | 48566     | 02204      | 50769      | 54 |
| 7  | 49269    | 97792    | 51478    | 48522     | 02208      | 50731      | 53 |
| 8  | 49308    | 97788    | 51520    | 48480     | 02212      | 50692      | 52 |
| 9  | 49347    | 97784    | 51563    | 48437     | 02216      | 50653      | 51 |
| 10 | 9. 49385 | 9. 97779 | 9. 51606 | 10. 48394 | 10. 02221  | 10. 50615  | 50 |
| 11 | 49424    | 97775    | 51648    | 48352     | 02225      | 50576      | 49 |
| 12 | 49462    | 97771    | 51691    | 48309     | 02229      | 50538      | 48 |
| 13 | 49500    | 97767    | 51734    | 48266     | 02233      | 50500      | 47 |
| 14 | 49539    | 97763    | 51776    | 48224     | 02237      | 50461      | 46 |
| 15 | 49577    | 97759    | 51819    | 48181     | 02241      | 50423      | 45 |
| 16 | 49615    | 97754    | 51861    | 48139     | 02246      | 50385      | 44 |
| 17 | 49654    | 97750    | 51903    | 48097     | 02250      | 50346      | 43 |
| 18 | 49692    | 97746    | 51946    | 48054     | 02254      | 50308      | 42 |
| 19 | 49730    | 97742    | 51988    | 48012     | 02258      | 50270      | 41 |
| 20 | 9. 49768 | 9. 97738 | 9. 52031 | 10. 47969 | 10. 02262  | 10. 50232  | 40 |
| 21 | 49806    | 97733    | 52073    | 47927     | 02266      | 50194      | 39 |
| 22 | 49844    | 97729    | 52115    | 47885     | 02271      | 50156      | 38 |
| 23 | 49882    | 97725    | 52157    | 47843     | 02275      | 50118      | 37 |
| 24 | 49920    | 97721    | 52200    | 47800     | 02279      | 50080      | 36 |
| 25 | 49958    | 97717    | 52242    | 47758     | 02283      | 50042      | 35 |
| 26 | 49996    | 97713    | 52284    | 47716     | 02287      | 50004      | 34 |
| 27 | 50034    | 97708    | 52326    | 47674     | 02292      | 49966      | 33 |
| 28 | 50072    | 97704    | 52368    | 47632     | 02296      | 49928      | 32 |
| 29 | 50110    | 97700    | 52410    | 47590     | 02300      | 49890      | 31 |
| 30 | 9. 50148 | 9. 97696 | 9. 52452 | 10. 47548 | 10. 02304  | 10. 49852  | 30 |
| 31 | 50185    | 97691    | 52494    | 47506     | 02309      | 49815      | 29 |
| 32 | 50223    | 97687    | 52536    | 47464     | 02313      | 49777      | 28 |
| 33 | 50261    | 97683    | 52578    | 47422     | 02317      | 49739      | 27 |
| 34 | 50298    | 97679    | 52620    | 47380     | 02321      | 49702      | 26 |
| 35 | 50336    | 97674    | 52661    | 47339     | 02326      | 49664      | 25 |
| 36 | 50373    | 97670    | 52703    | 47297     | 02330      | 49626      | 24 |
| 37 | 50411    | 97666    | 52745    | 47255     | 02334      | 49589      | 23 |
| 38 | 50448    | 97662    | 52787    | 47213     | 02338      | 49551      | 22 |
| 39 | 50486    | 97657    | 52829    | 47171     | 02343      | 49514      | 21 |
| 40 | 9. 50523 | 9. 97653 | 9. 52870 | 10. 47130 | 10. 02347  | 10. 49477  | 20 |
| 41 | 50561    | 97649    | 52912    | 47088     | 02351      | 49439      | 19 |
| 42 | 50598    | 97645    | 52953    | 47047     | 02355      | 49402      | 18 |
| 43 | 50635    | 97640    | 52995    | 47005     | 02360      | 49365      | 17 |
| 44 | 50673    | 97636    | 53037    | 46963     | 02364      | 49327      | 16 |
| 45 | 50710    | 97632    | 53078    | 46922     | 02368      | 49290      | 15 |
| 46 | 50747    | 97627    | 53120    | 46880     | 02372      | 49253      | 14 |
| 47 | 50784    | 97623    | 53161    | 46839     | 02377      | 49216      | 13 |
| 48 | 50821    | 97619    | 53202    | 46797     | 02381      | 49179      | 12 |
| 49 | 50858    | 97615    | 53244    | 46756     | 02385      | 49142      | 11 |
| 50 | 9. 50896 | 9. 97610 | 9. 53285 | 10. 46715 | 10. 02390  | 10. 49104  | 10 |
| 51 | 50933    | 97606    | 53327    | 46673     | 02394      | 49067      | 9  |
| 52 | 50970    | 97602    | 53368    | 46632     | 02398      | 49030      | 8  |
| 53 | 51006    | 97597    | 53409    | 46591     | 02403      | 48993      | 7  |
| 54 | 51043    | 97593    | 53450    | 46550     | 02407      | 48957      | 6  |
| 55 | 51080    | 97589    | 53492    | 46508     | 02411      | 48920      | 5  |
| 56 | 51117    | 97584    | 53533    | 46467     | 02416      | 48883      | 4  |
| 57 | 51154    | 97580    | 53574    | 46426     | 02420      | 48846      | 3  |
| 58 | 51191    | 97576    | 53615    | 46385     | 02424      | 48809      | 2  |
| 59 | 51227    | 97571    | 53656    | 46344     | 02429      | 48773      | 1  |
| 60 | 51264    | 97567    | 53697    | 46303     | 02433      | 48736      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    | M. |

71 Degrees.

TABLE V. OF ARTIFICIAL Sines, Tangents, and Secants. 19 Degrees.

| M. | Sine.    | Co-line. | Tangent. | Co-tang.  | Secant.    | Co-secant. |    |
|----|----------|----------|----------|-----------|------------|------------|----|
| 60 | 9. 51264 | 9. 97567 | 9. 53697 | 10. 46303 | 10. 02433  | 10. 48736  | 60 |
| 59 | 51304    | 97563    | 53738    | 46262     | 02437      | 48699      | 59 |
| 58 | 51337    | 97558    | 53779    | 46221     | 02442      | 48662      | 58 |
| 57 | 51374    | 97554    | 53820    | 46180     | 02446      | 48626      | 57 |
| 56 | 51411    | 97550    | 53861    | 46139     | 02450      | 48589      | 56 |
| 55 | 51447    | 97545    | 53902    | 46098     | 02455      | 48553      | 55 |
| 54 | 51484    | 97541    | 53943    | 46057     | 02459      | 48516      | 54 |
| 53 | 51520    | 97536    | 53984    | 46016     | 02464      | 48480      | 53 |
| 52 | 51557    | 97532    | 54025    | 45975     | 02468      | 48443      | 52 |
| 51 | 51593    | 97528    | 54065    | 45935     | 02472      | 48407      | 51 |
| 50 | 9. 51629 | 9. 97523 | 9. 54106 | 10. 45894 | 10. 02477  | 10. 48371  | 50 |
| 49 | 51666    | 97519    | 54147    | 45853     | 02481      | 48334      | 49 |
| 48 | 51702    | 97514    | 54187    | 45813     | 02485      | 48298      | 48 |
| 47 | 51738    | 97510    | 54228    | 45772     | 02490      | 48262      | 47 |
| 46 | 51774    | 97506    | 54269    | 45731     | 02494      | 48226      | 46 |
| 45 | 51811    | 97501    | 54309    | 45691     | 02499      | 48189      | 45 |
| 44 | 51847    | 97497    | 54350    | 45650     | 02503      | 48153      | 44 |
| 43 | 51883    | 97492    | 54390    | 45610     | 02508      | 48117      | 43 |
| 42 | 51919    | 97488    | 54431    | 45569     | 02512      | 48081      | 42 |
| 41 | 51955    | 97484    | 54471    | 45529     | 02516      | 48045      | 41 |
| 40 | 9. 51991 | 9. 97479 | 9. 54512 | 10. 45488 | 10. 02521  | 10. 48009  | 40 |
| 39 | 52027    | 97475    | 54552    | 45448     | 02525      | 47973      | 39 |
| 38 | 52063    | 97470    | 54593    | 45407     | 02530      | 47937      | 38 |
| 37 | 52099    | 97466    | 54633    | 45367     | 02534      | 47901      | 37 |
| 36 | 52135    | 97461    | 54673    | 45326     | 02539      | 47865      | 36 |
| 35 | 52171    | 97457    | 54714    | 45286     | 02543      | 47829      | 35 |
| 34 | 52207    | 97452    | 54754    | 45246     | 02547      | 47793      | 34 |
| 33 | 52242    | 97448    | 54794    | 45206     | 02552      | 47758      | 33 |
| 32 | 52278    | 97444    | 54835    | 45165     | 02556      | 47722      | 32 |
| 31 | 52314    | 97439    | 54875    | 45125     | 02561      | 47686      | 31 |
| 30 | 9. 52350 | 9. 97435 | 9. 54915 | 10. 45085 | 10. 02565  | 10. 47650  | 30 |
| 29 | 52385    | 97430    | 54955    | 45045     | 02570      | 47615      | 29 |
| 28 | 52421    | 97426    | 54995    | 45005     | 02574      | 47579      | 28 |
| 27 | 52456    | 97421    | 55035    | 44965     | 02579      | 47544      | 27 |
| 26 | 52492    | 97417    | 55075    | 44925     | 02583      | 47508      | 26 |
| 25 | 52527    | 97412    | 55115    | 44885     | 02588      | 47473      | 25 |
| 24 | 52563    | 97408    | 55155    | 44845     | 02592      | 47437      | 24 |
| 23 | 52598    | 97403    | 55195    | 44805     | 02597      | 47402      | 23 |
| 22 | 52634    | 97399    | 55235    | 44765     | 02601      | 47366      | 22 |
| 21 | 52669    | 97394    | 55275    | 44725     | 02606      | 47331      | 21 |
| 20 | 9. 52705 | 9. 97390 | 9. 55315 | 10. 44685 | 10. 02610  | 10. 47295  | 20 |
| 19 | 52740    | 97385    | 55355    | 44645     | 02615      | 47260      | 19 |
| 18 | 52775    | 97381    | 55395    | 44605     | 02619      | 47225      | 18 |
| 17 | 52810    | 97376    | 55434    | 44566     | 02624      | 47189      | 17 |
| 16 | 52846    | 97372    | 55474    | 44526     | 02628      | 47154      | 16 |
| 15 | 52881    | 97367    | 55514    | 44486     | 02633      | 47119      | 15 |
| 14 | 52916    | 97362    | 55554    | 44446     | 02637      | 47084      | 14 |
| 13 | 52951    | 97358    | 55593    | 44407     | 02642      | 47049      | 13 |
| 12 | 52986    | 97353    | 55633    | 44367     | 02647      | 47014      | 12 |
| 11 | 53021    | 97349    | 55673    | 44327     | 02651      | 46979      | 11 |
| 10 | 9. 53056 | 9. 97344 | 9. 55712 | 10. 44288 | 10. 02656  | 10. 46944  | 10 |
| 9  | 53091    | 97340    | 55752    | 44248     | 02660      | 46908      | 9  |
| 8  | 53126    | 97335    | 55791    | 44209     | 02665      | 46873      | 8  |
| 7  | 53161    | 97331    | 55831    | 44169     | 02669      | 46839      | 7  |
| 6  | 53196    | 97326    | 55870    | 44130     | 02674      | 46804      | 6  |
| 5  | 53231    | 97322    | 55910    | 44090     | 02678      | 46769      | 5  |
| 4  | 53266    | 97317    | 55949    | 44051     | 02683      | 46734      | 4  |
| 3  | 53301    | 97312    | 55989    | 44011     | 02688      | 46699      | 3  |
| 2  | 53336    | 97308    | 56028    | 43972     | 02692      | 46664      | 2  |
| 1  | 53370    | 97303    | 56067    | 43933     | 02697      | 46630      | 1  |
| 0  | 53405    | 97299    | 56107    | 43893     | 02701      | 46595      | 0  |
|    | Co-line. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    | M. |

70 Degrees.



TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants, 20 Degree

| M. | Sine.    | Co-line. | Tangent. | Co-tang. | Secant.    | Co-secant. |
|----|----------|----------|----------|----------|------------|------------|
| 0  | 9.53405  | 9.97299  | 9.56107  | 10.43893 | 10.02701   | 10.46595   |
| 1  | 53440    | 97294    | 56146    | 43854    | 02706      | 46560      |
| 2  | 53475    | 97289    | 56185    | 43815    | 02711      | 46525      |
| 3  | 53509    | 97285    | 56224    | 43776    | 02715      | 46491      |
| 4  | 53544    | 97280    | 56264    | 43736    | 02720      | 46456      |
| 5  | 53578    | 97275    | 56303    | 43697    | 02724      | 46422      |
| 6  | 53613    | 97271    | 56342    | 43658    | 02729      | 46387      |
| 7  | 53647    | 97266    | 56381    | 43619    | 02734      | 46353      |
| 8  | 53682    | 97262    | 56420    | 43580    | 02738      | 46318      |
| 9  | 53716    | 97257    | 56459    | 43541    | 02743      | 46284      |
| 10 | 9.53751  | 9.97252  | 9.56498  | 10.43502 | 10.02748   | 10.46249   |
| 11 | 53785    | 97248    | 56537    | 43463    | 02752      | 46215      |
| 12 | 53819    | 97243    | 56576    | 43424    | 02757      | 46181      |
| 13 | 53854    | 97238    | 56615    | 43385    | 02762      | 46146      |
| 14 | 53888    | 97234    | 56654    | 43346    | 02766      | 46112      |
| 15 | 53922    | 97229    | 56693    | 43307    | 02771      | 46078      |
| 16 | 53957    | 97224    | 56732    | 43268    | 02776      | 46043      |
| 17 | 53991    | 97220    | 56771    | 43229    | 02780      | 46009      |
| 18 | 54025    | 97215    | 56810    | 43190    | 02785      | 45975      |
| 19 | 54059    | 97210    | 56849    | 43151    | 02789      | 45941      |
| 20 | 9.54093  | 9.97206  | 9.56887  | 10.43113 | 10.02794   | 10.45909   |
| 21 | 54127    | 97201    | 56926    | 43074    | 02799      | 45873      |
| 22 | 54161    | 97196    | 56965    | 43035    | 02804      | 45839      |
| 23 | 54195    | 97192    | 57004    | 42996    | 02808      | 45805      |
| 24 | 54229    | 97187    | 57042    | 42958    | 02813      | 45771      |
| 25 | 54263    | 97182    | 57081    | 42919    | 02818      | 45737      |
| 26 | 54297    | 97178    | 57120    | 42880    | 02822      | 45703      |
| 27 | 54331    | 97173    | 57158    | 42842    | 02827      | 45669      |
| 28 | 54365    | 97168    | 57197    | 42803    | 02832      | 45635      |
| 29 | 54399    | 97163    | 57235    | 42765    | 02837      | 45601      |
| 30 | 9.54432  | 9.97159  | 9.57274  | 10.42726 | 10.02841   | 10.45567   |
| 31 | 54466    | 97154    | 57312    | 42688    | 02846      | 45534      |
| 32 | 54500    | 97149    | 57351    | 42649    | 02851      | 45500      |
| 33 | 54534    | 97145    | 57389    | 42611    | 02855      | 45466      |
| 34 | 54567    | 97140    | 57428    | 42572    | 02860      | 45433      |
| 35 | 54601    | 97135    | 57466    | 42534    | 02865      | 45399      |
| 36 | 54635    | 97130    | 57504    | 42496    | 02870      | 45365      |
| 37 | 54668    | 97126    | 57543    | 42457    | 02874      | 45332      |
| 38 | 54702    | 97121    | 57581    | 42419    | 02879      | 45298      |
| 39 | 54735    | 97116    | 57619    | 42381    | 02884      | 45265      |
| 40 | 9.54769  | 9.97111  | 9.57658  | 10.42342 | 10.02889   | 10.45231   |
| 41 | 54802    | 97106    | 57696    | 42304    | 02893      | 45198      |
| 42 | 54836    | 97102    | 57734    | 42266    | 02898      | 45164      |
| 43 | 54869    | 97097    | 57772    | 42228    | 02903      | 45131      |
| 44 | 54903    | 97092    | 57810    | 42190    | 02908      | 45097      |
| 45 | 54936    | 97087    | 57849    | 42151    | 02913      | 45064      |
| 46 | 54969    | 97083    | 57887    | 42113    | 02917      | 45031      |
| 47 | 55003    | 97078    | 57925    | 42075    | 02922      | 44997      |
| 48 | 55036    | 97073    | 57963    | 42037    | 02927      | 44964      |
| 49 | 55069    | 97068    | 58001    | 41999    | 02932      | 44931      |
| 50 | 9.55102  | 9.97063  | 9.58039  | 10.41961 | 10.02937   | 10.44898   |
| 51 | 55136    | 97059    | 58077    | 41923    | 02941      | 44864      |
| 52 | 55169    | 97054    | 58115    | 41885    | 02946      | 44831      |
| 53 | 55202    | 97049    | 58153    | 41847    | 02951      | 44798      |
| 54 | 55235    | 97044    | 58191    | 41809    | 02956      | 44765      |
| 55 | 55268    | 97039    | 58229    | 41771    | 02961      | 44732      |
| 56 | 55301    | 97034    | 58267    | 41733    | 02965      | 44699      |
| 57 | 55334    | 97030    | 58304    | 41696    | 02970      | 44666      |
| 58 | 55367    | 97025    | 58342    | 41658    | 02975      | 44633      |
| 59 | 55400    | 97020    | 58380    | 41620    | 02980      | 44600      |
| 60 | 55433    | 97015    | 58418    | 41582    | 02985      | 44567      |
|    | Co-line. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    |

69 Degrees.

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 21 Degrees.

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 60 | 9.55433  | 9.97015  | 9.58418  | 10.41582 | 10.02985   | 10.44567   | 60 |
| 59 | 55466    | 97010    | 58455    | 41545    | 02990      | 44534      | 59 |
| 58 | 55499    | 97005    | 58493    | 41507    | 02995      | 44501      | 58 |
| 57 | 55531    | 97001    | 58531    | 41469    | 02999      | 44468      | 57 |
| 56 | 55564    | 96996    | 58569    | 41431    | 03004      | 44436      | 56 |
| 55 | 55597    | 96991    | 58606    | 41394    | 03009      | 44403      | 55 |
| 54 | 55630    | 96986    | 58644    | 41356    | 03014      | 44370      | 54 |
| 53 | 55663    | 96981    | 58681    | 41319    | 03019      | 44337      | 53 |
| 52 | 55695    | 96976    | 58719    | 41281    | 03024      | 44305      | 52 |
| 51 | 55728    | 96971    | 58757    | 41243    | 03029      | 44272      | 51 |
| 50 | 9.55761  | 9.96966  | 9.58794  | 10.41206 | 10.03034   | 10.44239   | 50 |
| 49 | 55793    | 96962    | 58832    | 41168    | 03038      | 44207      | 49 |
| 48 | 55826    | 96957    | 58869    | 41131    | 03043      | 44174      | 48 |
| 47 | 55858    | 96952    | 58907    | 41093    | 03048      | 44142      | 47 |
| 46 | 55891    | 96947    | 58944    | 41056    | 03053      | 44109      | 46 |
| 45 | 55923    | 96942    | 58981    | 41019    | 03058      | 44077      | 45 |
| 44 | 55956    | 96937    | 59019    | 40981    | 03063      | 44044      | 44 |
| 43 | 55988    | 96932    | 59056    | 40944    | 03068      | 44012      | 43 |
| 42 | 56021    | 96927    | 59094    | 40906    | 03073      | 43979      | 42 |
| 41 | 56053    | 96922    | 59131    | 40869    | 03078      | 43947      | 41 |
| 40 | 9.56085  | 9.96917  | 9.59168  | 10.40832 | 10.03083   | 10.43914   | 40 |
| 39 | 56118    | 96912    | 59205    | 40795    | 03088      | 43882      | 39 |
| 38 | 56150    | 96907    | 59243    | 40757    | 03093      | 43850      | 38 |
| 37 | 56182    | 96903    | 59280    | 40720    | 03097      | 43818      | 37 |
| 36 | 56215    | 96898    | 59317    | 40683    | 03102      | 43785      | 36 |
| 35 | 56247    | 96893    | 59354    | 40646    | 03107      | 43753      | 35 |
| 34 | 56279    | 96888    | 59391    | 40609    | 03112      | 43721      | 34 |
| 33 | 56311    | 96883    | 59429    | 40571    | 03117      | 43689      | 33 |
| 32 | 56343    | 96878    | 59466    | 40534    | 03122      | 43657      | 32 |
| 31 | 56375    | 96873    | 59503    | 40497    | 03127      | 43625      | 31 |
| 30 | 9.56408  | 9.96868  | 9.59540  | 10.40460 | 10.03132   | 10.43592   | 30 |
| 29 | 56440    | 96863    | 59577    | 40423    | 03137      | 43560      | 29 |
| 28 | 56472    | 96858    | 59614    | 40386    | 03142      | 43528      | 28 |
| 27 | 56504    | 96853    | 59651    | 40349    | 03147      | 43496      | 27 |
| 26 | 56536    | 96848    | 59688    | 40312    | 03152      | 43464      | 26 |
| 25 | 56568    | 96843    | 59725    | 40275    | 03157      | 43432      | 25 |
| 24 | 56599    | 96838    | 59762    | 40238    | 03162      | 43400      | 24 |
| 23 | 56631    | 96833    | 59799    | 40201    | 03167      | 43369      | 23 |
| 22 | 56663    | 96828    | 59835    | 40165    | 03172      | 43337      | 22 |
| 21 | 56695    | 96823    | 59872    | 40128    | 03177      | 43305      | 21 |
| 20 | 9.56727  | 9.96818  | 9.59909  | 10.40091 | 10.03182   | 10.43273   | 20 |
| 19 | 56759    | 96813    | 59946    | 40054    | 03187      | 43241      | 19 |
| 18 | 56790    | 96808    | 59983    | 40017    | 03192      | 43210      | 18 |
| 17 | 56822    | 96803    | 60019    | 39981    | 03197      | 43178      | 17 |
| 16 | 56854    | 96798    | 60056    | 39944    | 03202      | 43146      | 16 |
| 15 | 56886    | 96793    | 60093    | 39907    | 03207      | 43114      | 15 |
| 14 | 56917    | 96788    | 60130    | 39870    | 03212      | 43083      | 14 |
| 13 | 56949    | 96783    | 60166    | 39834    | 03217      | 43051      | 13 |
| 12 | 56980    | 96778    | 60203    | 39797    | 03222      | 43020      | 12 |
| 11 | 57012    | 96772    | 60240    | 39760    | 03228      | 42988      | 11 |
| 10 | 9.57044  | 9.96767  | 9.60276  | 10.39724 | 10.03232   | 10.42956   | 10 |
| 9  | 57075    | 96762    | 60313    | 39687    | 03238      | 42925      | 9  |
| 8  | 57107    | 96757    | 60349    | 39651    | 03243      | 42893      | 8  |
| 7  | 57138    | 96752    | 60386    | 39614    | 03248      | 42862      | 7  |
| 6  | 57169    | 96747    | 60422    | 39578    | 03253      | 42830      | 6  |
| 5  | 57201    | 96742    | 60459    | 39541    | 03258      | 42799      | 5  |
| 4  | 57232    | 96737    | 60495    | 39505    | 03263      | 42768      | 4  |
| 3  | 57264    | 96732    | 60532    | 39468    | 03268      | 42736      | 3  |
| 2  | 57295    | 96727    | 60568    | 39432    | 03273      | 42705      | 2  |
| 1  | 57326    | 96722    | 60605    | 39395    | 03278      | 42674      | 1  |
| 0  | 57357    | 96717    | 60641    | 39359    | 03283      | 42642      | 0  |
| M. | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |

TABLE V. OF ARTIFICIAL Sines, Tangents, and Secants. 22 Degree

| M. | Sine.    | Co-sine. | Tangent. | Co-tang.  | Secant.    | Co-secant. |    |
|----|----------|----------|----------|-----------|------------|------------|----|
| 0  | 9. 57358 | 9. 96717 | 9. 00641 | 10. 39359 | 10. 03283  | 10. 42642  | 60 |
| 1  | 57389    | 96711    | 60677    | 39323     | 03289      | 42611      | 59 |
| 2  | 57420    | 96706    | 60714    | 39286     | 03294      | 42580      | 58 |
| 3  | 57451    | 96701    | 60750    | 39250     | 03299      | 42549      | 57 |
| 4  | 57482    | 96696    | 60786    | 39214     | 03304      | 42518      | 56 |
| 5  | 57514    | 96691    | 60823    | 39177     | 03309      | 42486      | 55 |
| 6  | 57545    | 96686    | 60859    | 39141     | 03314      | 42455      | 54 |
| 7  | 57576    | 96681    | 60895    | 39105     | 03319      | 42424      | 53 |
| 8  | 57607    | 96676    | 60931    | 39069     | 03324      | 42393      | 52 |
| 9  | 57638    | 96670    | 60967    | 39033     | 03330      | 42362      | 51 |
| 10 | 9. 57669 | 9. 96665 | 9. 61004 | 10. 38996 | 10. 03335  | 10. 42331  | 50 |
| 11 | 57700    | 96660    | 61040    | 38960     | 03340      | 42300      | 49 |
| 12 | 57731    | 96655    | 61076    | 38924     | 03345      | 42269      | 48 |
| 13 | 57762    | 96650    | 61112    | 38888     | 03350      | 42238      | 47 |
| 14 | 57793    | 96645    | 61148    | 38852     | 03355      | 42207      | 46 |
| 15 | 57824    | 96640    | 61184    | 38816     | 03360      | 42176      | 45 |
| 16 | 57854    | 96634    | 61220    | 38780     | 03366      | 42145      | 44 |
| 17 | 57885    | 96629    | 61256    | 38744     | 03371      | 42115      | 43 |
| 18 | 57916    | 96624    | 61292    | 38708     | 03376      | 42084      | 42 |
| 19 | 57947    | 96619    | 61328    | 38672     | 03381      | 42053      | 41 |
| 20 | 9. 57978 | 9. 96614 | 9. 61364 | 10. 38636 | 10. 03386  | 10. 42022  | 40 |
| 21 | 58008    | 96608    | 61400    | 38600     | 03392      | 41992      | 39 |
| 22 | 58039    | 96603    | 61436    | 38564     | 03397      | 41961      | 38 |
| 23 | 58070    | 96598    | 61472    | 38528     | 03402      | 41930      | 37 |
| 24 | 58100    | 96593    | 61508    | 38492     | 03407      | 41899      | 36 |
| 25 | 58131    | 96588    | 61544    | 38456     | 03412      | 41869      | 35 |
| 26 | 58162    | 96582    | 61579    | 38421     | 03418      | 41838      | 34 |
| 27 | 58192    | 96577    | 61615    | 38385     | 03423      | 41808      | 33 |
| 28 | 58223    | 96572    | 61651    | 38349     | 03428      | 41777      | 32 |
| 29 | 58253    | 96567    | 61687    | 38313     | 03433      | 41747      | 31 |
| 30 | 9. 58284 | 9. 96562 | 9. 61722 | 10. 38278 | 10. 03438  | 10. 41716  | 30 |
| 31 | 58314    | 96556    | 61758    | 38242     | 03444      | 41686      | 29 |
| 32 | 58345    | 96551    | 61794    | 38206     | 03449      | 41655      | 28 |
| 33 | 58375    | 96546    | 61830    | 38170     | 03454      | 41625      | 27 |
| 34 | 58406    | 96541    | 61865    | 38135     | 03459      | 41594      | 26 |
| 35 | 58436    | 96535    | 61901    | 38099     | 03465      | 41564      | 25 |
| 36 | 58467    | 96530    | 61936    | 38063     | 03470      | 41533      | 24 |
| 37 | 58497    | 96525    | 61972    | 38028     | 03475      | 41503      | 23 |
| 38 | 58527    | 96520    | 62008    | 37992     | 03480      | 41473      | 22 |
| 39 | 58557    | 96514    | 62043    | 37957     | 03486      | 41443      | 21 |
| 40 | 9. 58588 | 9. 96509 | 9. 62079 | 10. 37921 | 10. 03491  | 10. 41412  | 20 |
| 41 | 58618    | 96504    | 62114    | 37886     | 03496      | 41382      | 19 |
| 42 | 58648    | 96498    | 62150    | 37850     | 03502      | 41352      | 18 |
| 43 | 58678    | 96493    | 62185    | 37815     | 03507      | 41322      | 17 |
| 44 | 58708    | 96488    | 62221    | 37779     | 03512      | 41291      | 16 |
| 45 | 58739    | 96483    | 62256    | 37744     | 03517      | 41261      | 15 |
| 46 | 58769    | 96477    | 62291    | 37708     | 03523      | 41231      | 14 |
| 47 | 58799    | 96472    | 62327    | 37673     | 03528      | 41201      | 13 |
| 48 | 58829    | 96467    | 62362    | 37638     | 03533      | 41171      | 12 |
| 49 | 58859    | 96461    | 62398    | 37602     | 03539      | 41141      | 11 |
| 50 | 9. 58889 | 9. 96456 | 9. 62433 | 10. 37567 | 10. 03544  | 10. 41111  | 10 |
| 51 | 58919    | 96451    | 62468    | 37532     | 03549      | 41081      | 9  |
| 52 | 58949    | 96445    | 62504    | 37496     | 03555      | 41051      | 8  |
| 53 | 58979    | 96440    | 62539    | 37461     | 03560      | 41021      | 7  |
| 54 | 59009    | 96435    | 62574    | 37426     | 03565      | 40991      | 6  |
| 55 | 59039    | 96429    | 62609    | 37391     | 03571      | 40961      | 5  |
| 56 | 59069    | 96424    | 62645    | 37355     | 03576      | 40931      | 4  |
| 57 | 59098    | 96419    | 62680    | 37320     | 03581      | 40902      | 3  |
| 58 | 59128    | 96413    | 62715    | 37285     | 03587      | 40872      | 2  |
| 59 | 59158    | 96408    | 62750    | 37250     | 03592      | 40842      | 1  |
| 60 | 59188    | 96403    | 62785    | 37215     | 03597      | 40812      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    | M. |

67 Degrees.



TABLE V. OF ARTIFICIAL Sines, Tangents, and Secants. 23 Degrees.

| M.       | Sine.    | Co-sine. | Tangent. | Co-tang.   | Secant.   | Co-secant. |    |
|----------|----------|----------|----------|------------|-----------|------------|----|
| 0        | 9. 59188 | 9. 96403 | 9. 62785 | 10. 37215  | 10. 03597 | 10. 40812  | 60 |
| 1        | 59217    | 96397    | 62820    | 37180      | 03603     | 40782      | 59 |
| 2        | 59247    | 96392    | 62855    | 37145      | 03608     | 40753      | 58 |
| 3        | 59277    | 96386    | 62890    | 37110      | 03613     | 40723      | 57 |
| 4        | 59307    | 96381    | 62926    | 37074      | 03619     | 40693      | 56 |
| 5        | 59336    | 96376    | 62961    | 37039      | 03624     | 40664      | 55 |
| 6        | 59366    | 96370    | 62996    | 37004      | 03630     | 40634      | 54 |
| 7        | 59396    | 96364    | 63031    | 36969      | 03635     | 40604      | 53 |
| 8        | 59425    | 96360    | 63066    | 36934      | 03640     | 40575      | 52 |
| 9        | 59455    | 96354    | 63101    | 36899      | 03646     | 40545      | 51 |
| 10       | 9. 59484 | 9. 96349 | 9. 63135 | 10. 36865  | 10. 03651 | 10. 40516  | 50 |
| 11       | 59514    | 96343    | 63170    | 36830      | 03657     | 40486      | 49 |
| 12       | 59543    | 96338    | 63205    | 36795      | 03662     | 40457      | 48 |
| 13       | 59573    | 96333    | 63240    | 36760      | 03667     | 40427      | 47 |
| 14       | 59602    | 96327    | 63275    | 36725      | 03673     | 40398      | 46 |
| 15       | 59632    | 96322    | 63310    | 36690      | 03678     | 40368      | 45 |
| 16       | 59661    | 96316    | 63345    | 36655      | 03684     | 40339      | 44 |
| 17       | 59690    | 96311    | 63379    | 36620      | 03689     | 40310      | 43 |
| 18       | 59720    | 96305    | 63414    | 36586      | 03695     | 40280      | 42 |
| 19       | 59749    | 96300    | 63449    | 36551      | 03700     | 40251      | 41 |
| 20       | 9. 59778 | 9. 96294 | 9. 63484 | 10. 36516  | 10. 03706 | 10. 40222  | 40 |
| 21       | 59808    | 96289    | 63519    | 36481      | 03711     | 40192      | 39 |
| 22       | 59837    | 96284    | 63553    | 36447      | 03716     | 40163      | 38 |
| 23       | 59866    | 96278    | 63588    | 36412      | 03722     | 40134      | 37 |
| 24       | 59895    | 96273    | 63623    | 36377      | 03727     | 40105      | 36 |
| 25       | 59924    | 96267    | 63657    | 36343      | 03733     | 40076      | 35 |
| 26       | 59954    | 96262    | 63692    | 36308      | 03738     | 40046      | 34 |
| 27       | 59983    | 96256    | 63726    | 36274      | 03744     | 40017      | 33 |
| 28       | 60012    | 96251    | 63761    | 36239      | 03749     | 49988      | 32 |
| 29       | 60041    | 96245    | 63796    | 36204      | 03755     | 49959      | 31 |
| 30       | 9. 60070 | 9. 96240 | 9. 63830 | 10. 36170  | 10. 03760 | 10. 39930  | 30 |
| 31       | 60099    | 96234    | 63865    | 36135      | 03766     | 39901      | 29 |
| 32       | 60128    | 96229    | 63899    | 36101      | 03771     | 39872      | 28 |
| 33       | 60157    | 96223    | 63934    | 36066      | 03777     | 39843      | 27 |
| 34       | 60186    | 96218    | 63968    | 36032      | 03782     | 39814      | 26 |
| 35       | 60215    | 96212    | 64003    | 35997      | 03788     | 39785      | 25 |
| 36       | 60244    | 96207    | 64037    | 35963      | 03793     | 39756      | 24 |
| 37       | 60273    | 96201    | 64072    | 35928      | 03798     | 39727      | 23 |
| 38       | 60302    | 96196    | 64106    | 35894      | 03804     | 39698      | 22 |
| 39       | 60331    | 96190    | 64140    | 35860      | 03810     | 39669      | 21 |
| 40       | 9. 60359 | 9. 96185 | 9. 64175 | 10. 35825  | 10. 03815 | 10. 39641  | 20 |
| 41       | 60388    | 96179    | 64209    | 35791      | 03821     | 39612      | 19 |
| 42       | 60417    | 96174    | 64243    | 35757      | 03826     | 39583      | 18 |
| 43       | 60446    | 96168    | 64278    | 35722      | 03832     | 39554      | 17 |
| 44       | 60474    | 96162    | 64312    | 35688      | 03838     | 39525      | 16 |
| 45       | 60503    | 96157    | 64346    | 35654      | 03843     | 39497      | 15 |
| 46       | 60532    | 96151    | 64381    | 35619      | 03849     | 39468      | 14 |
| 47       | 60561    | 96146    | 64415    | 35585      | 03855     | 39439      | 13 |
| 48       | 60589    | 96140    | 64449    | 35551      | 03860     | 39411      | 12 |
| 49       | 60618    | 96135    | 64483    | 35517      | 03866     | 39382      | 11 |
| 50       | 9. 60646 | 9. 96129 | 9. 64517 | 10. 35483  | 10. 03871 | 10. 39353  | 10 |
| 51       | 60675    | 96123    | 64552    | 35448      | 03877     | 39325      | 9  |
| 52       | 60704    | 96118    | 64586    | 35414      | 03882     | 39296      | 8  |
| 53       | 60732    | 96112    | 64620    | 35380      | 03888     | 39268      | 7  |
| 54       | 60761    | 96107    | 64654    | 35346      | 03893     | 39239      | 6  |
| 55       | 60789    | 96101    | 64688    | 35312      | 03899     | 39211      | 5  |
| 56       | 60818    | 96095    | 64722    | 35278      | 03905     | 39182      | 4  |
| 57       | 60846    | 96090    | 64756    | 35244      | 03910     | 39154      | 3  |
| 58       | 60874    | 96084    | 64790    | 35210      | 03916     | 39125      | 2  |
| 59       | 60903    | 96079    | 64824    | 35176      | 03921     | 39097      | 1  |
| 60       | 60931    | 96073    | 64858    | 35142      | 03927     | 39069      | 0  |
| Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.   | M.         |    |

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 24 Degree

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 9.60931  | 9.96073  | 9.64858  | 10.35142 | 10.03927   | 10.39069   | 60 |
| 1  | 60960    | 96067    | 64892    | 35108    | 03933      | 39040      | 59 |
| 2  | 60988    | 96062    | 64926    | 35074    | 03938      | 39012      | 58 |
| 3  | 61016    | 96056    | 64960    | 35040    | 03944      | 38984      | 57 |
| 4  | 61045    | 96050    | 64994    | 35006    | 03950      | 38955      | 56 |
| 5  | 61073    | 96045    | 65028    | 34972    | 03955      | 38927      | 55 |
| 6  | 61101    | 96039    | 65062    | 34938    | 03961      | 38899      | 54 |
| 7  | 61129    | 96034    | 65096    | 34904    | 03966      | 38871      | 53 |
| 8  | 61158    | 96028    | 65130    | 34870    | 03972      | 38842      | 52 |
| 9  | 61186    | 96022    | 65164    | 34836    | 03978      | 38814      | 51 |
| 10 | 9.61214  | 9.96017  | 9.65197  | 10.34803 | 10.03983   | 10.38786   | 50 |
| 11 | 61242    | 96011    | 65231    | 34769    | 03989      | 38758      | 49 |
| 12 | 61270    | 96005    | 65265    | 34735    | 03995      | 38730      | 48 |
| 13 | 61298    | 95999    | 65299    | 34701    | 04000      | 38702      | 47 |
| 14 | 61326    | 95994    | 65333    | 34667    | 04006      | 38674      | 46 |
| 15 | 61354    | 95988    | 65366    | 34634    | 04012      | 38646      | 45 |
| 16 | 61382    | 95982    | 65400    | 34600    | 04018      | 38618      | 44 |
| 17 | 61411    | 95977    | 65434    | 34566    | 04023      | 38589      | 43 |
| 18 | 61438    | 95971    | 65467    | 34533    | 04029      | 38561      | 42 |
| 19 | 61466    | 95965    | 65501    | 34499    | 04035      | 38534      | 41 |
| 20 | 9.61494  | 9.95960  | 9.65535  | 10.34465 | 10.04040   | 10.38506   | 40 |
| 21 | 61522    | 95954    | 65568    | 34432    | 04046      | 38478      | 39 |
| 22 | 61550    | 95948    | 65602    | 34398    | 04052      | 38450      | 38 |
| 23 | 61578    | 95942    | 65636    | 34364    | 04058      | 38422      | 37 |
| 24 | 61606    | 95937    | 65669    | 34331    | 04063      | 38394      | 36 |
| 25 | 61634    | 95931    | 65703    | 34297    | 04069      | 38366      | 35 |
| 26 | 61662    | 95925    | 65736    | 34264    | 04075      | 38338      | 34 |
| 27 | 61689    | 95920    | 65770    | 34230    | 04080      | 38311      | 33 |
| 28 | 61717    | 95914    | 65803    | 34197    | 04086      | 38283      | 32 |
| 29 | 61745    | 95908    | 65837    | 34163    | 04092      | 38255      | 31 |
| 30 | 9.61773  | 9.95902  | 9.65870  | 10.34130 | 10.04098   | 10.38227   | 30 |
| 31 | 61800    | 95896    | 65904    | 34096    | 04103      | 38200      | 29 |
| 32 | 61828    | 95891    | 65937    | 34063    | 04109      | 38172      | 28 |
| 33 | 61856    | 95885    | 65971    | 34029    | 04115      | 38144      | 27 |
| 34 | 61883    | 95879    | 66004    | 33996    | 04121      | 38117      | 26 |
| 35 | 61911    | 95873    | 66038    | 33962    | 04127      | 38089      | 25 |
| 36 | 61939    | 95868    | 66071    | 33929    | 04132      | 38061      | 24 |
| 37 | 61966    | 95862    | 66104    | 33896    | 04138      | 38034      | 23 |
| 38 | 61994    | 95856    | 66138    | 33862    | 04144      | 38006      | 22 |
| 39 | 62021    | 95850    | 66171    | 33829    | 04150      | 37979      | 21 |
| 40 | 9.62049  | 9.95844  | 9.66204  | 10.33796 | 10.04156   | 10.37951   | 20 |
| 41 | 62076    | 95839    | 66238    | 33762    | 04161      | 37924      | 19 |
| 42 | 62104    | 95833    | 66271    | 33729    | 04167      | 37896      | 18 |
| 43 | 62131    | 95827    | 66304    | 33696    | 04173      | 37869      | 17 |
| 44 | 62159    | 95821    | 66337    | 33663    | 04179      | 37841      | 16 |
| 45 | 62186    | 95815    | 66371    | 33629    | 04185      | 37814      | 15 |
| 46 | 62214    | 95810    | 66404    | 33596    | 04190      | 37786      | 14 |
| 47 | 62241    | 95804    | 66437    | 33563    | 04196      | 37759      | 13 |
| 48 | 62268    | 95798    | 66470    | 33530    | 04202      | 37732      | 12 |
| 49 | 62296    | 95792    | 66503    | 33497    | 04208      | 37704      | 11 |
| 50 | 9.62323  | 9.95786  | 9.66537  | 10.33463 | 10.04214   | 10.37677   | 10 |
| 51 | 62350    | 95780    | 66570    | 33430    | 04220      | 37650      | 9  |
| 52 | 62377    | 95775    | 66603    | 33397    | 04225      | 37623      | 8  |
| 53 | 62405    | 95769    | 66636    | 33364    | 04231      | 37595      | 7  |
| 54 | 62432    | 95763    | 66669    | 33331    | 04237      | 37568      | 6  |
| 55 | 62459    | 95757    | 66702    | 33298    | 04243      | 37541      | 5  |
| 56 | 62486    | 95751    | 66735    | 33265    | 04249      | 37514      | 4  |
| 57 | 62513    | 95745    | 66768    | 33232    | 04255      | 37487      | 3  |
| 58 | 62541    | 95739    | 66801    | 33199    | 04261      | 37459      | 2  |
| 59 | 62568    | 95733    | 66834    | 33166    | 04267      | 37432      | 1  |
| 60 | 62595    | 95728    | 66867    | 33133    | 04272      | 37405      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |

65 Degrees.

TABLE V. OF ARTIFICIAL Sines, Tangents, and Secants. 25 Degrees.

|    | M. | Sine.    | Co-line. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----|----------|----------|----------|----------|------------|------------|----|
| 60 | 0  | 9.62595  | 9.95728  | 9.66867  | 10.33133 | 10.04272   | 10.37405   | 60 |
| 59 | 1  | 62622    | 95722    | 66900    | 33100    | 04278      | 37378      | 59 |
| 58 | 2  | 62649    | 95716    | 66933    | 33067    | 04284      | 37351      | 58 |
| 57 | 3  | 62676    | 95710    | 66966    | 33034    | 04290      | 37324      | 57 |
| 56 | 4  | 62703    | 95704    | 66999    | 33001    | 04296      | 37297      | 56 |
| 55 | 5  | 62730    | 95698    | 67032    | 32968    | 04302      | 37270      | 55 |
| 54 | 6  | 62757    | 95692    | 67065    | 32935    | 04308      | 37243      | 54 |
| 53 | 7  | 62784    | 95686    | 67098    | 32902    | 04314      | 37216      | 53 |
| 52 | 8  | 62811    | 95680    | 67131    | 32869    | 04320      | 37189      | 52 |
| 51 | 9  | 62838    | 95674    | 67163    | 32837    | 04326      | 37162      | 51 |
| 50 | 10 | 9.62865  | 9.95668  | 9.67196  | 10.32804 | 10.04332   | 10.37135   | 50 |
| 49 | 11 | 62892    | 95662    | 67229    | 32771    | 04337      | 37108      | 49 |
| 48 | 12 | 62918    | 95657    | 67262    | 32738    | 04343      | 37082      | 48 |
| 47 | 13 | 62945    | 95651    | 67295    | 32705    | 04349      | 37055      | 47 |
| 46 | 14 | 62972    | 95645    | 67327    | 32673    | 04355      | 37028      | 46 |
| 45 | 15 | 62999    | 95639    | 67360    | 32640    | 04361      | 37001      | 45 |
| 44 | 16 | 63026    | 95633    | 67393    | 32607    | 04367      | 36974      | 44 |
| 43 | 17 | 63052    | 95627    | 67426    | 32574    | 04373      | 36948      | 43 |
| 42 | 18 | 63079    | 95621    | 67458    | 32542    | 04379      | 36921      | 42 |
| 41 | 19 | 63106    | 95615    | 67491    | 32509    | 04385      | 36894      | 41 |
| 40 | 20 | 9.63133  | 9.95609  | 9.67524  | 10.32476 | 10.04391   | 10.36867   | 40 |
| 39 | 21 | 63159    | 95603    | 67556    | 32444    | 04397      | 36841      | 39 |
| 38 | 22 | 63186    | 95597    | 67589    | 32411    | 04403      | 36814      | 38 |
| 37 | 23 | 63212    | 95591    | 67622    | 32378    | 04409      | 36787      | 37 |
| 36 | 24 | 63239    | 95585    | 67654    | 32346    | 04415      | 36761      | 36 |
| 35 | 25 | 63266    | 95579    | 67687    | 32313    | 04421      | 36734      | 35 |
| 34 | 26 | 63292    | 95573    | 67719    | 32281    | 04427      | 36708      | 34 |
| 33 | 27 | 63319    | 95567    | 67752    | 32248    | 04433      | 36681      | 33 |
| 32 | 28 | 63345    | 95561    | 67785    | 32215    | 04439      | 36655      | 32 |
| 31 | 29 | 63372    | 95555    | 67817    | 32183    | 04445      | 36628      | 31 |
| 30 | 30 | 9.63398  | 9.95549  | 9.67850  | 10.32150 | 10.04451   | 10.36602   | 30 |
| 29 | 31 | 63425    | 95543    | 67882    | 32118    | 04457      | 36575      | 29 |
| 28 | 32 | 63451    | 95537    | 67915    | 32085    | 04463      | 36549      | 28 |
| 27 | 33 | 63478    | 95531    | 67947    | 32053    | 04469      | 36522      | 27 |
| 26 | 34 | 63504    | 95525    | 67980    | 32020    | 04475      | 36496      | 26 |
| 25 | 35 | 63531    | 95519    | 68012    | 31988    | 04481      | 36469      | 25 |
| 24 | 36 | 63557    | 95513    | 68044    | 31956    | 04487      | 36443      | 24 |
| 23 | 37 | 63583    | 95507    | 68077    | 31923    | 04493      | 36417      | 23 |
| 22 | 38 | 63610    | 95500    | 68109    | 31891    | 04500      | 36390      | 22 |
| 21 | 39 | 63636    | 95494    | 68142    | 31858    | 04506      | 36364      | 21 |
| 20 | 40 | 9.63662  | 9.95488  | 9.68174  | 10.31826 | 10.04512   | 10.36338   | 20 |
| 19 | 41 | 63689    | 95482    | 68206    | 31794    | 04518      | 36311      | 19 |
| 18 | 42 | 63715    | 95476    | 68239    | 31761    | 04524      | 36285      | 18 |
| 17 | 43 | 63741    | 95470    | 68271    | 31729    | 04530      | 36259      | 17 |
| 16 | 44 | 63767    | 95464    | 68303    | 31697    | 04536      | 36233      | 16 |
| 15 | 45 | 63793    | 95458    | 68336    | 31664    | 04542      | 36206      | 15 |
| 14 | 46 | 63820    | 95452    | 68368    | 31632    | 04548      | 36180      | 14 |
| 13 | 47 | 63846    | 95446    | 68400    | 31600    | 04554      | 36154      | 13 |
| 12 | 48 | 63872    | 95440    | 68432    | 31568    | 04560      | 36128      | 12 |
| 11 | 49 | 63898    | 95434    | 68465    | 31535    | 04566      | 36102      | 11 |
| 10 | 50 | 9.63924  | 9.95427  | 9.68497  | 10.31503 | 10.04573   | 10.36076   | 10 |
| 9  | 51 | 63950    | 95421    | 68529    | 31471    | 04579      | 36050      | 9  |
| 8  | 52 | 63976    | 95415    | 68561    | 31439    | 04585      | 36024      | 8  |
| 7  | 53 | 64002    | 95409    | 68593    | 31407    | 04591      | 35998      | 7  |
| 6  | 54 | 64028    | 95403    | 68626    | 31374    | 04597      | 35972      | 6  |
| 5  | 55 | 64054    | 95397    | 68658    | 31342    | 04603      | 35946      | 5  |
| 4  | 56 | 64080    | 95391    | 68690    | 31310    | 04609      | 35920      | 4  |
| 3  | 57 | 64106    | 95384    | 68722    | 31278    | 04616      | 35894      | 3  |
| 2  | 58 | 64132    | 95378    | 68754    | 31246    | 04622      | 35868      | 2  |
| 1  | 59 | 64158    | 95372    | 68786    | 31214    | 04628      | 35842      | 1  |
| 0  | 60 | 64184    | 95366    | 68818    | 31182    | 04634      | 35816      | 0  |
| M. |    | Co-line. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |



TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 24 Degree

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 9.60931  | 9.96073  | 9.64858  | 10.35142 | 10.03927   | 10.39069   | 60 |
| 1  | 60960    | 96067    | 64892    | 35108    | 03933      | 39040      | 59 |
| 2  | 60988    | 96062    | 64926    | 35074    | 03938      | 39012      | 58 |
| 3  | 61016    | 96056    | 64960    | 35040    | 03944      | 38984      | 57 |
| 4  | 61045    | 96050    | 64994    | 35006    | 03950      | 38955      | 56 |
| 5  | 61073    | 96045    | 65028    | 34972    | 03955      | 38927      | 55 |
| 6  | 61101    | 96039    | 65062    | 34938    | 03961      | 38899      | 54 |
| 7  | 61129    | 96034    | 65096    | 34904    | 03966      | 38871      | 53 |
| 8  | 61158    | 96028    | 65130    | 34870    | 03972      | 38842      | 52 |
| 9  | 61186    | 96022    | 65164    | 34836    | 03978      | 38814      | 51 |
| 10 | 9.61214  | 9.96017  | 9.65197  | 10.34803 | 10.03983   | 10.38786   | 50 |
| 11 | 61242    | 96011    | 65231    | 34769    | 03989      | 38758      | 49 |
| 12 | 61270    | 96005    | 65265    | 34735    | 03995      | 38730      | 48 |
| 13 | 61298    | 95999    | 65299    | 34701    | 04000      | 38702      | 47 |
| 14 | 61326    | 95994    | 65333    | 34667    | 04006      | 38674      | 46 |
| 15 | 61354    | 95988    | 65366    | 34634    | 04012      | 38646      | 45 |
| 16 | 61382    | 95982    | 65400    | 34600    | 04018      | 38618      | 44 |
| 17 | 61411    | 95977    | 65434    | 34566    | 04023      | 38589      | 43 |
| 18 | 61438    | 95971    | 65467    | 34533    | 04029      | 38561      | 42 |
| 19 | 61466    | 95965    | 65501    | 34499    | 04035      | 38534      | 41 |
| 20 | 9.61494  | 9.95960  | 9.65535  | 10.34465 | 10.04040   | 10.38506   | 40 |
| 21 | 61522    | 95954    | 65568    | 34432    | 04046      | 38478      | 39 |
| 22 | 61550    | 95948    | 65602    | 34398    | 04052      | 38450      | 38 |
| 23 | 61578    | 95942    | 65636    | 34364    | 04058      | 38422      | 37 |
| 24 | 61606    | 95937    | 65669    | 34331    | 04063      | 38394      | 36 |
| 25 | 61634    | 95931    | 65703    | 34297    | 04069      | 38366      | 35 |
| 26 | 61662    | 95925    | 65736    | 34264    | 04075      | 38338      | 34 |
| 27 | 61689    | 95920    | 65770    | 34230    | 04080      | 38311      | 33 |
| 28 | 61717    | 95914    | 65803    | 34197    | 04086      | 38283      | 32 |
| 29 | 61745    | 95908    | 65837    | 34163    | 04092      | 38255      | 31 |
| 30 | 9.61773  | 9.95902  | 9.65870  | 10.34130 | 10.04098   | 10.38227   | 30 |
| 31 | 61800    | 95896    | 65904    | 34096    | 04103      | 38200      | 29 |
| 32 | 61828    | 95891    | 65937    | 34063    | 04109      | 38172      | 28 |
| 33 | 61856    | 95885    | 65971    | 34029    | 04115      | 38144      | 27 |
| 34 | 61883    | 95879    | 66004    | 33996    | 04121      | 38117      | 26 |
| 35 | 61911    | 95873    | 66038    | 33962    | 04127      | 38089      | 25 |
| 36 | 61939    | 95868    | 66071    | 33929    | 04132      | 38061      | 24 |
| 37 | 61966    | 95862    | 66104    | 33896    | 04138      | 38034      | 23 |
| 38 | 61994    | 95856    | 66138    | 33862    | 04144      | 38006      | 22 |
| 39 | 62021    | 95850    | 66171    | 33829    | 04150      | 37979      | 21 |
| 40 | 9.62049  | 9.95844  | 9.66204  | 10.33796 | 10.04156   | 10.37951   | 20 |
| 41 | 62076    | 95839    | 66238    | 33762    | 04161      | 37924      | 19 |
| 42 | 62104    | 95833    | 66271    | 33729    | 04167      | 37896      | 18 |
| 43 | 62131    | 95827    | 66304    | 33696    | 04173      | 37869      | 17 |
| 44 | 62159    | 95821    | 66337    | 33663    | 04179      | 37841      | 16 |
| 45 | 62186    | 95815    | 66371    | 33629    | 04185      | 37814      | 15 |
| 46 | 62214    | 95810    | 66404    | 33596    | 04190      | 37786      | 14 |
| 47 | 62241    | 95804    | 66437    | 33563    | 04196      | 37759      | 13 |
| 48 | 62268    | 95798    | 66470    | 33530    | 04202      | 37732      | 12 |
| 49 | 62296    | 95792    | 66503    | 33497    | 04208      | 37704      | 11 |
| 50 | 9.62323  | 9.95786  | 9.66537  | 10.33463 | 10.04214   | 10.37677   | 10 |
| 51 | 62350    | 95780    | 66570    | 33430    | 04220      | 37650      | 9  |
| 52 | 62377    | 95775    | 66603    | 33397    | 04225      | 37623      | 8  |
| 53 | 62405    | 95769    | 66636    | 33364    | 04231      | 37595      | 7  |
| 54 | 62432    | 95763    | 66669    | 33331    | 04237      | 37568      | 6  |
| 55 | 62459    | 95757    | 66702    | 33298    | 04243      | 37541      | 5  |
| 56 | 62486    | 95751    | 66735    | 33265    | 04249      | 37514      | 4  |
| 57 | 62513    | 95745    | 66768    | 33232    | 04255      | 37487      | 3  |
| 58 | 62541    | 95739    | 66801    | 33199    | 04261      | 37459      | 2  |
| 59 | 62568    | 95733    | 66834    | 33166    | 04267      | 37432      | 1  |
| 60 | 62595    | 95728    | 66867    | 33133    | 04272      | 37405      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |

65 Degrees.

TABLE V. OF ARTIFICIAL Sines, Tangents, and Secants. 25 Degrees.

| M. | Sine.    | Co-line. | Tangent. | Co-tang.  | Secant.    | Co-secant. |    |
|----|----------|----------|----------|-----------|------------|------------|----|
| 60 | 9. 62595 | 9. 95728 | 9. 66867 | 10. 33133 | 10. 04272  | 10. 37405  | 60 |
| 59 | 62622    | 95722    | 66900    | 33100     | 04278      | 37378      | 59 |
| 58 | 62649    | 95716    | 66933    | 33067     | 04284      | 37351      | 58 |
| 57 | 62676    | 95710    | 66966    | 33034     | 04290      | 37324      | 57 |
| 56 | 62703    | 95704    | 66999    | 33001     | 04296      | 37297      | 56 |
| 55 | 62730    | 95698    | 67032    | 32968     | 04302      | 37270      | 55 |
| 54 | 62757    | 95692    | 67065    | 32935     | 04308      | 37243      | 54 |
| 53 | 62784    | 95686    | 67098    | 32902     | 04314      | 37216      | 53 |
| 52 | 62811    | 95680    | 67131    | 32869     | 04320      | 37189      | 52 |
| 51 | 62838    | 95674    | 67163    | 32837     | 04326      | 37162      | 51 |
| 50 | 9. 62865 | 9. 95668 | 9. 67196 | 10. 32804 | 10. 04332  | 10. 37135  | 50 |
| 49 | 62892    | 95662    | 67229    | 32771     | 04337      | 37108      | 49 |
| 48 | 62918    | 95657    | 67262    | 32738     | 04343      | 37082      | 48 |
| 47 | 62945    | 95651    | 67295    | 32705     | 04349      | 37055      | 47 |
| 46 | 62972    | 95645    | 67327    | 32673     | 04355      | 37028      | 46 |
| 45 | 62999    | 95639    | 67360    | 32640     | 04361      | 37001      | 45 |
| 44 | 63026    | 95633    | 67393    | 32607     | 04367      | 36974      | 44 |
| 43 | 63052    | 95627    | 67426    | 32574     | 04373      | 36948      | 43 |
| 42 | 63079    | 95621    | 67458    | 32542     | 04379      | 36921      | 42 |
| 41 | 63106    | 95615    | 67491    | 32509     | 04385      | 36894      | 41 |
| 40 | 9. 63133 | 9. 95609 | 9. 67524 | 10. 32476 | 10. 04391  | 10. 36867  | 40 |
| 39 | 63159    | 95603    | 67556    | 32444     | 04397      | 36841      | 39 |
| 38 | 63186    | 95597    | 67589    | 32411     | 04403      | 36814      | 38 |
| 37 | 63212    | 95591    | 67622    | 32378     | 04409      | 36787      | 37 |
| 36 | 63239    | 95585    | 67654    | 32346     | 04415      | 36761      | 36 |
| 35 | 63266    | 95579    | 67687    | 32313     | 04421      | 36734      | 35 |
| 34 | 63292    | 95573    | 67719    | 32281     | 04427      | 36708      | 34 |
| 33 | 63319    | 95567    | 67752    | 32248     | 04433      | 36681      | 33 |
| 32 | 63345    | 95561    | 67785    | 32215     | 04439      | 36655      | 32 |
| 31 | 63372    | 95555    | 67817    | 32183     | 04445      | 36628      | 31 |
| 30 | 9. 63398 | 9. 95549 | 9. 67850 | 10. 32150 | 10. 04451  | 10. 36602  | 30 |
| 29 | 63425    | 95543    | 67882    | 32118     | 04457      | 36575      | 29 |
| 28 | 63451    | 95537    | 67915    | 32085     | 04463      | 36549      | 28 |
| 27 | 63478    | 95531    | 67947    | 32053     | 04469      | 36522      | 27 |
| 26 | 63504    | 95525    | 67980    | 32020     | 04475      | 36496      | 26 |
| 25 | 63531    | 95519    | 68012    | 31988     | 04481      | 36469      | 25 |
| 24 | 63557    | 95513    | 68044    | 31956     | 04487      | 36443      | 24 |
| 23 | 63583    | 95507    | 68077    | 31923     | 04493      | 36417      | 23 |
| 22 | 63610    | 95500    | 68109    | 31891     | 04500      | 36390      | 22 |
| 21 | 63636    | 95494    | 68142    | 31858     | 04506      | 36364      | 21 |
| 20 | 9. 63662 | 9. 95488 | 9. 68174 | 10. 31826 | 10. 04512  | 10. 36338  | 20 |
| 19 | 63689    | 95482    | 68206    | 31794     | 04518      | 36311      | 19 |
| 18 | 63715    | 95476    | 68239    | 31761     | 04524      | 36285      | 18 |
| 17 | 63741    | 95470    | 68271    | 31729     | 04530      | 36259      | 17 |
| 16 | 63767    | 95464    | 68303    | 31697     | 04536      | 36233      | 16 |
| 15 | 63793    | 95458    | 68336    | 31664     | 04542      | 36206      | 15 |
| 14 | 63820    | 95452    | 68368    | 31632     | 04548      | 36180      | 14 |
| 13 | 63846    | 95446    | 68400    | 31600     | 04554      | 36154      | 13 |
| 12 | 63872    | 95440    | 68432    | 31568     | 04560      | 36128      | 12 |
| 11 | 63898    | 95434    | 68465    | 31535     | 04566      | 36102      | 11 |
| 10 | 9. 63924 | 9. 95427 | 9. 68497 | 10. 31503 | 10. 04573  | 10. 36076  | 10 |
| 9  | 63950    | 95421    | 68529    | 31471     | 04579      | 36050      | 9  |
| 8  | 63976    | 95415    | 68561    | 31439     | 04585      | 36024      | 8  |
| 7  | 64002    | 95409    | 68593    | 31407     | 04591      | 35998      | 7  |
| 6  | 64028    | 95403    | 68626    | 31374     | 04597      | 35972      | 6  |
| 5  | 64054    | 95397    | 68658    | 31342     | 04603      | 35946      | 5  |
| 4  | 64080    | 95391    | 68690    | 31310     | 04609      | 35920      | 4  |
| 3  | 64106    | 95384    | 68722    | 31278     | 04616      | 35894      | 3  |
| 2  | 64132    | 95378    | 68754    | 31246     | 04622      | 35868      | 2  |
| 1  | 64158    | 95372    | 68786    | 31214     | 04628      | 35842      | 1  |
| 0  | 64184    | 95366    | 68818    | 31182     | 04634      | 35816      | 0  |
|    | Co-line. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    | M. |

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 26 Degree

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |
|----|----------|----------|----------|----------|------------|------------|
| 0  | 9.64184  | 9.95366  | 9.08818  | 10.31182 | 10.04634   | 10.35816   |
| 1  | 64210    | 95360    | 68850    | 31150    | 04640      | 35790      |
| 2  | 64236    | 95354    | 68882    | 31118    | 04646      | 35764      |
| 3  | 64262    | 95348    | 68914    | 31086    | 04652      | 35738      |
| 4  | 64288    | 95341    | 68946    | 31054    | 04659      | 35712      |
| 5  | 64313    | 95335    | 68978    | 31022    | 04665      | 35687      |
| 6  | 64339    | 95329    | 69010    | 30990    | 04671      | 35661      |
| 7  | 64365    | 95323    | 69042    | 30958    | 04677      | 35635      |
| 8  | 64391    | 95317    | 69074    | 30926    | 04683      | 35609      |
| 9  | 64417    | 95310    | 69106    | 30894    | 04690      | 35583      |
| 10 | 9.64442  | 9.95304  | 9.69138  | 10.30862 | 10.04696   | 10.35558   |
| 11 | 64468    | 95298    | 69170    | 30830    | 04702      | 35532      |
| 12 | 64494    | 95292    | 69202    | 30798    | 04708      | 35506      |
| 13 | 64519    | 95286    | 69234    | 30766    | 04714      | 35481      |
| 14 | 64545    | 95279    | 69266    | 30734    | 04721      | 35455      |
| 15 | 64571    | 95273    | 69298    | 30702    | 04727      | 35429      |
| 16 | 64596    | 95267    | 69329    | 30671    | 04733      | 35404      |
| 17 | 64622    | 95261    | 69361    | 30639    | 04739      | 35378      |
| 18 | 64647    | 95254    | 69393    | 30607    | 04746      | 35353      |
| 19 | 64673    | 95248    | 69425    | 30575    | 04752      | 35327      |
| 20 | 9.64698  | 9.95242  | 9.69457  | 10.30543 | 10.04758   | 10.35302   |
| 21 | 64724    | 95236    | 69488    | 30512    | 04764      | 35276      |
| 22 | 64749    | 95229    | 69520    | 30480    | 04771      | 35251      |
| 23 | 64775    | 95223    | 69552    | 30448    | 04777      | 35225      |
| 24 | 64800    | 95217    | 69584    | 30416    | 04783      | 35200      |
| 25 | 64826    | 95211    | 69615    | 30385    | 04789      | 35174      |
| 26 | 64851    | 95204    | 69647    | 30353    | 04796      | 35149      |
| 27 | 64877    | 95198    | 69679    | 30321    | 04802      | 35123      |
| 28 | 64902    | 95192    | 69710    | 30290    | 04808      | 35098      |
| 29 | 64927    | 95185    | 69742    | 30258    | 04815      | 35073      |
| 30 | 9.64953  | 9.95179  | 9.69774  | 10.30226 | 10.04821   | 10.35047   |
| 31 | 64978    | 95173    | 69805    | 30195    | 04827      | 35022      |
| 32 | 65003    | 95167    | 69837    | 30163    | 04833      | 34997      |
| 33 | 65029    | 95160    | 69868    | 30132    | 04840      | 34971      |
| 34 | 65054    | 95154    | 69900    | 30100    | 04846      | 34946      |
| 35 | 65079    | 95148    | 69932    | 30068    | 04852      | 34921      |
| 36 | 65104    | 95141    | 69963    | 30037    | 04859      | 34896      |
| 37 | 65130    | 95135    | 69995    | 30005    | 04865      | 34870      |
| 38 | 65155    | 95129    | 70026    | 29974    | 04871      | 34845      |
| 39 | 65180    | 95122    | 70058    | 29942    | 04878      | 34820      |
| 40 | 9.65205  | 9.95116  | 9.70089  | 10.29911 | 10.04884   | 10.34795   |
| 41 | 65230    | 95110    | 70121    | 29879    | 04890      | 34770      |
| 42 | 65255    | 95103    | 70152    | 29848    | 04897      | 34745      |
| 43 | 65281    | 95097    | 70184    | 29816    | 04903      | 34719      |
| 44 | 65306    | 95090    | 70215    | 29785    | 04910      | 34694      |
| 45 | 65331    | 95084    | 70247    | 29753    | 04916      | 34669      |
| 46 | 65356    | 95078    | 70278    | 29722    | 04922      | 34644      |
| 47 | 65381    | 95071    | 70309    | 29691    | 04929      | 34619      |
| 48 | 65406    | 95065    | 70341    | 29659    | 04935      | 34594      |
| 49 | 65431    | 95059    | 70372    | 29628    | 04941      | 34569      |
| 50 | 9.65456  | 9.95052  | 9.70404  | 10.29396 | 10.04948   | 10.34344   |
| 51 | 65481    | 95046    | 70435    | 29565    | 04954      | 34519      |
| 52 | 65506    | 95039    | 70466    | 29534    | 04961      | 34494      |
| 53 | 65531    | 95033    | 70498    | 29502    | 04967      | 34469      |
| 54 | 65556    | 95027    | 70529    | 29471    | 04973      | 34444      |
| 55 | 65580    | 95020    | 70560    | 29440    | 04980      | 34420      |
| 56 | 65605    | 95014    | 70592    | 29408    | 04986      | 34395      |
| 57 | 65630    | 95007    | 70623    | 29377    | 04993      | 34370      |
| 58 | 65655    | 95001    | 70654    | 29346    | 04999      | 34345      |
| 59 | 65680    | 94994    | 70685    | 29315    | 05005      | 34320      |
| 60 | 65705    | 94988    | 70717    | 20283    | 05012      | 34295      |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    |



TABLE V. OF ARTIFICIAL Sines, Tangents, and Secants. 27 Degrees.

| M.       | Sine.    | Co-fine. | Tangent. | Co-tang.   | Secant.   | Co-secant. |    |
|----------|----------|----------|----------|------------|-----------|------------|----|
| 0        | 9. 65705 | 9. 94988 | 9. 70717 | 10. 29283  | 10. 05012 | 10. 34295  | 60 |
| 1        | 65729    | 94982    | 70748    | 29252      | 05018     | 34271      | 59 |
| 2        | 65754    | 94975    | 70779    | 29221      | 05025     | 34246      | 58 |
| 3        | 65779    | 94969    | 70810    | 29190      | 05031     | 34221      | 57 |
| 4        | 65804    | 94962    | 70841    | 29159      | 05038     | 34196      | 56 |
| 5        | 65828    | 94956    | 70873    | 29127      | 05044     | 34172      | 55 |
| 6        | 65853    | 94949    | 70904    | 29096      | 05051     | 34147      | 54 |
| 7        | 65878    | 94943    | 70935    | 29065      | 05057     | 34122      | 53 |
| 8        | 65902    | 94936    | 70966    | 29034      | 05064     | 34098      | 52 |
| 9        | 65927    | 94930    | 70997    | 29003      | 05070     | 34073      | 51 |
| 10       | 9. 65952 | 9. 94923 | 9. 71028 | 10. 28972  | 10. 05077 | 10. 34048  | 50 |
| 11       | 65976    | 94917    | 71059    | 28941      | 05083     | 34024      | 49 |
| 12       | 66001    | 94910    | 71090    | 28910      | 05089     | 33999      | 48 |
| 13       | 66025    | 94904    | 71121    | 28879      | 05096     | 33975      | 47 |
| 14       | 66050    | 94898    | 71153    | 28847      | 05102     | 33950      | 46 |
| 15       | 66075    | 94891    | 71184    | 28816      | 05109     | 33925      | 45 |
| 16       | 66099    | 94884    | 71215    | 28785      | 05115     | 33901      | 44 |
| 17       | 66124    | 94878    | 71246    | 28754      | 05122     | 33876      | 43 |
| 18       | 66148    | 94871    | 71277    | 28723      | 05129     | 33852      | 42 |
| 19       | 66173    | 94865    | 71308    | 28692      | 05135     | 33827      | 41 |
| 20       | 9. 66197 | 9. 94858 | 9. 71339 | 10. 28661  | 10. 05142 | 10. 33803  | 40 |
| 21       | 66221    | 94852    | 71370    | 28630      | 05148     | 33779      | 39 |
| 22       | 66246    | 94845    | 71401    | 28599      | 05155     | 33754      | 38 |
| 23       | 66270    | 94839    | 71431    | 28568      | 05161     | 33730      | 37 |
| 24       | 66295    | 94832    | 71462    | 28538      | 05168     | 33705      | 36 |
| 25       | 66319    | 94826    | 71493    | 28507      | 05174     | 33681      | 35 |
| 26       | 66343    | 94819    | 71524    | 28476      | 05181     | 33657      | 34 |
| 27       | 66368    | 94813    | 71555    | 28445      | 05187     | 33632      | 33 |
| 28       | 66392    | 94806    | 71586    | 28414      | 05194     | 33608      | 32 |
| 29       | 66416    | 94799    | 71617    | 28383      | 05201     | 33584      | 31 |
| 30       | 9. 66441 | 9. 94793 | 9. 71648 | 10. 28352  | 10. 05207 | 10. 33559  | 30 |
| 31       | 66465    | 94786    | 71679    | 28321      | 05214     | 33535      | 29 |
| 32       | 66489    | 94780    | 71709    | 28291      | 05220     | 33511      | 28 |
| 33       | 66513    | 94773    | 71740    | 28260      | 05227     | 33487      | 27 |
| 34       | 66537    | 94767    | 71771    | 28229      | 05233     | 33463      | 26 |
| 35       | 66562    | 94760    | 71802    | 28198      | 05240     | 33438      | 25 |
| 36       | 66586    | 94753    | 71833    | 28167      | 05247     | 33414      | 24 |
| 37       | 66610    | 94747    | 71863    | 28137      | 05253     | 33390      | 23 |
| 38       | 66634    | 94740    | 71894    | 28106      | 05260     | 33366      | 22 |
| 39       | 66658    | 94734    | 71925    | 28075      | 05266     | 33342      | 21 |
| 40       | 9. 66682 | 9. 94727 | 9. 71955 | 10. 28045  | 10. 05273 | 10. 33318  | 20 |
| 41       | 66706    | 94720    | 71986    | 28014      | 05280     | 33293      | 19 |
| 42       | 66731    | 94714    | 72017    | 27983      | 05286     | 33269      | 18 |
| 43       | 66755    | 94707    | 72048    | 27952      | 05293     | 33245      | 17 |
| 44       | 66779    | 94700    | 72078    | 27922      | 05300     | 33221      | 16 |
| 45       | 66803    | 94694    | 72109    | 27891      | 05306     | 33197      | 15 |
| 46       | 66827    | 94687    | 72140    | 27860      | 05313     | 33173      | 14 |
| 47       | 66851    | 94680    | 72170    | 27830      | 05320     | 33149      | 13 |
| 48       | 66875    | 94674    | 72201    | 27799      | 05326     | 33125      | 12 |
| 49       | 66899    | 94667    | 72231    | 27769      | 05333     | 33101      | 11 |
| 50       | 9. 66922 | 9. 94660 | 9. 72262 | 10. 27738  | 10. 05340 | 10. 33078  | 10 |
| 51       | 66946    | 94654    | 72293    | 27707      | 05346     | 33054      | 9  |
| 52       | 66970    | 94647    | 72323    | 27678      | 05353     | 33030      | 8  |
| 53       | 66994    | 94640    | 72354    | 27646      | 05360     | 33006      | 7  |
| 54       | 67018    | 94634    | 72384    | 27616      | 05366     | 32982      | 6  |
| 55       | 67042    | 94627    | 72415    | 27585      | 05373     | 32958      | 5  |
| 56       | 67066    | 94620    | 72445    | 27555      | 05380     | 32934      | 4  |
| 57       | 67090    | 94614    | 72476    | 27524      | 05386     | 32910      | 3  |
| 58       | 67113    | 94607    | 72506    | 27493      | 05393     | 32887      | 2  |
| 59       | 67137    | 94600    | 72537    | 27463      | 05400     | 32863      | 1  |
| 60       | 67161    | 94593    | 72567    | 27433      | 05407     | 32839      | 0  |
| Co-fine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.   | M.         |    |

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 28 Degree

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 9.67161  | 9.94593  | 9.72567  | 10.27433 | 10.05407   | 10.32839   | 60 |
| 1  | 67185    | 94587    | 72598    | 27402    | 05413      | 32813      | 59 |
| 2  | 67208    | 94580    | 72628    | 27372    | 05420      | 32792      | 58 |
| 3  | 67232    | 94573    | 72659    | 27341    | 05427      | 32768      | 57 |
| 4  | 67256    | 94567    | 72689    | 27311    | 05433      | 32744      | 56 |
| 5  | 67280    | 94560    | 72720    | 27280    | 05440      | 32720      | 55 |
| 6  | 67303    | 94553    | 72750    | 27250    | 05447      | 32697      | 54 |
| 7  | 67327    | 94546    | 72780    | 27220    | 05454      | 32673      | 53 |
| 8  | 67350    | 94540    | 72811    | 27189    | 05460      | 32650      | 52 |
| 9  | 67374    | 94533    | 72841    | 27159    | 05467      | 32625      | 51 |
| 10 | 9.67398  | 9.94526  | 9.72872  | 10.27128 | 10.05474   | 10.32602   | 50 |
| 11 | 67421    | 94519    | 72902    | 27098    | 05481      | 32579      | 49 |
| 12 | 67445    | 94513    | 72932    | 27068    | 05487      | 32555      | 48 |
| 13 | 67468    | 94506    | 72963    | 27037    | 05494      | 32532      | 47 |
| 14 | 67492    | 94499    | 72993    | 27007    | 05501      | 32508      | 46 |
| 15 | 67515    | 94492    | 73023    | 26977    | 05508      | 32485      | 45 |
| 16 | 67539    | 94485    | 73054    | 26946    | 05515      | 32461      | 44 |
| 17 | 67562    | 94479    | 73084    | 26916    | 05521      | 32438      | 43 |
| 18 | 67586    | 94472    | 73114    | 26886    | 05528      | 32414      | 42 |
| 19 | 67609    | 94465    | 73144    | 26856    | 05535      | 32391      | 41 |
| 20 | 9.67633  | 9.94458  | 9.73175  | 10.26825 | 10.05532   | 10.32367   | 40 |
| 21 | 67656    | 94451    | 73205    | 26795    | 05549      | 32344      | 39 |
| 22 | 67680    | 94445    | 73235    | 26765    | 05555      | 32320      | 38 |
| 23 | 67703    | 94438    | 73265    | 26735    | 05562      | 32297      | 37 |
| 24 | 67726    | 94431    | 73295    | 26705    | 05569      | 32274      | 36 |
| 25 | 67750    | 94424    | 73326    | 26674    | 05576      | 32250      | 35 |
| 26 | 67773    | 94417    | 73356    | 26644    | 05583      | 32227      | 34 |
| 27 | 67796    | 94410    | 73386    | 26614    | 05590      | 32204      | 33 |
| 28 | 67820    | 94404    | 73416    | 26584    | 05596      | 32180      | 32 |
| 29 | 67843    | 94397    | 73446    | 26554    | 05603      | 32157      | 31 |
| 30 | 9.67866  | 9.94390  | 9.73476  | 10.26524 | 10.05610   | 10.32134   | 30 |
| 31 | 67890    | 94383    | 73507    | 26493    | 05617      | 32110      | 29 |
| 32 | 67913    | 94376    | 73537    | 26463    | 05624      | 32087      | 28 |
| 33 | 67936    | 94369    | 73567    | 26433    | 05631      | 32064      | 27 |
| 34 | 67959    | 94362    | 73597    | 26403    | 05638      | 32041      | 26 |
| 35 | 67982    | 94355    | 73627    | 26373    | 05645      | 32018      | 25 |
| 36 | 68006    | 94349    | 73657    | 26343    | 05651      | 31994      | 24 |
| 37 | 68029    | 94342    | 73687    | 26313    | 05658      | 31971      | 23 |
| 38 | 68052    | 94335    | 73717    | 26283    | 05665      | 31948      | 22 |
| 39 | 68075    | 94328    | 73747    | 26253    | 05672      | 31925      | 21 |
| 40 | 9.68098  | 9.94321  | 9.73777  | 10.26223 | 10.05679   | 10.31902   | 20 |
| 41 | 68121    | 94314    | 73807    | 26193    | 05686      | 31879      | 19 |
| 42 | 68144    | 94307    | 73837    | 26163    | 05693      | 31856      | 18 |
| 43 | 68167    | 94300    | 73867    | 26133    | 05700      | 31833      | 17 |
| 44 | 68190    | 94293    | 73897    | 26103    | 05707      | 31810      | 16 |
| 45 | 68213    | 94286    | 73927    | 26073    | 05714      | 31787      | 15 |
| 46 | 68237    | 94279    | 73957    | 26043    | 05721      | 31763      | 14 |
| 47 | 68260    | 94273    | 73987    | 26013    | 05727      | 31740      | 13 |
| 48 | 68282    | 94266    | 74017    | 25983    | 05734      | 31718      | 12 |
| 49 | 68305    | 94259    | 74047    | 25953    | 05741      | 31695      | 11 |
| 50 | 9.68328  | 9.94252  | 9.74077  | 10.25923 | 10.05748   | 10.31672   | 10 |
| 51 | 68351    | 94245    | 74107    | 25893    | 05755      | 31649      | 9  |
| 52 | 68374    | 94238    | 74137    | 25863    | 05762      | 31626      | 8  |
| 53 | 68397    | 94231    | 74166    | 25833    | 05769      | 31603      | 7  |
| 54 | 68420    | 94224    | 74196    | 25803    | 05776      | 31580      | 6  |
| 55 | 68443    | 94217    | 74226    | 25774    | 05783      | 31557      | 5  |
| 56 | 68466    | 94210    | 74256    | 25744    | 05790      | 31534      | 4  |
| 57 | 68489    | 94203    | 74286    | 25714    | 05797      | 31511      | 3  |
| 58 | 68511    | 94196    | 74316    | 25684    | 05804      | 31488      | 2  |
| 59 | 68534    | 94189    | 74345    | 25655    | 05811      | 31466      | 1  |
| 60 | 68557    | 94182    | 74375    | 25625    | 05818      | 31443      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 29 Degrees.

| M. | Sine.    | Co-line. | Tangent. | Co-tang. | Secant.    | Co-secant. | M. |
|----|----------|----------|----------|----------|------------|------------|----|
| 60 | 9.68557  | 9.94182  | 9.74375  | 10.25625 | 10.05818   | 10.31443   | 60 |
| 59 | 68580    | 94175    | 74405    | 25595    | 05825      | 31420      | 59 |
| 58 | 68603    | 94168    | 74435    | 25565    | 05832      | 31397      | 58 |
| 57 | 68625    | 94161    | 74465    | 25535    | 05839      | 31375      | 57 |
| 56 | 68648    | 94154    | 74495    | 25506    | 05846      | 31352      | 56 |
| 55 | 68671    | 94147    | 74524    | 25476    | 05853      | 31329      | 55 |
| 54 | 68694    | 94140    | 74554    | 25446    | 05860      | 31306      | 54 |
| 53 | 68716    | 94133    | 74583    | 25417    | 05867      | 31284      | 53 |
| 52 | 68739    | 94126    | 74613    | 25387    | 05874      | 31261      | 52 |
| 51 | 68762    | 94119    | 74643    | 25357    | 05881      | 31238      | 51 |
| 50 | 9.68784  | 9.94112  | 9.74673  | 10.25327 | 10.05888   | 10.31216   | 50 |
| 49 | 68807    | 94105    | 74702    | 25298    | 05895      | 31193      | 49 |
| 48 | 68829    | 94098    | 74732    | 25268    | 05902      | 31170      | 48 |
| 47 | 68852    | 94090    | 74762    | 25238    | 05910      | 31148      | 47 |
| 46 | 68875    | 94083    | 74791    | 25209    | 05917      | 31125      | 46 |
| 45 | 68897    | 94076    | 74821    | 25179    | 05924      | 31103      | 45 |
| 44 | 68920    | 94069    | 74851    | 25149    | 05931      | 31080      | 44 |
| 43 | 68942    | 94062    | 74880    | 25120    | 05938      | 31058      | 43 |
| 42 | 68965    | 94055    | 74910    | 25090    | 05945      | 31035      | 42 |
| 41 | 68987    | 94048    | 74939    | 25061    | 05952      | 31013      | 41 |
| 40 | 9.69010  | 9.94041  | 9.74969  | 10.25031 | 10.05959   | 10.30990   | 40 |
| 39 | 69032    | 94034    | 74998    | 25002    | 05966      | 30968      | 39 |
| 38 | 69055    | 94027    | 75028    | 24972    | 05973      | 30945      | 38 |
| 37 | 69077    | 94020    | 75058    | 24942    | 05980      | 30923      | 37 |
| 36 | 69100    | 94012    | 75087    | 24913    | 05988      | 30900      | 36 |
| 35 | 69122    | 94005    | 75117    | 24883    | 05995      | 30878      | 35 |
| 34 | 69144    | 93998    | 75146    | 24854    | 06002      | 30856      | 34 |
| 33 | 69167    | 93991    | 75176    | 24824    | 06009      | 30833      | 33 |
| 32 | 69189    | 93984    | 75205    | 24795    | 06016      | 30811      | 32 |
| 31 | 69212    | 93977    | 75235    | 24765    | 06023      | 30788      | 31 |
| 30 | 9.69234  | 9.93970  | 9.75264  | 10.24736 | 10.06030   | 10.30766   | 30 |
| 29 | 69256    | 93963    | 75294    | 24706    | 06037      | 30744      | 29 |
| 28 | 69279    | 93955    | 75323    | 24677    | 06045      | 30721      | 28 |
| 27 | 69301    | 93948    | 75353    | 24647    | 06052      | 30699      | 27 |
| 26 | 69323    | 93941    | 75382    | 24618    | 06059      | 30677      | 26 |
| 25 | 69345    | 93934    | 75411    | 24588    | 06066      | 30655      | 25 |
| 24 | 69368    | 93927    | 75441    | 24559    | 06073      | 30632      | 24 |
| 23 | 69390    | 93919    | 75470    | 24530    | 06080      | 30610      | 23 |
| 22 | 69412    | 93912    | 75500    | 24500    | 06088      | 30588      | 22 |
| 21 | 69434    | 93905    | 75529    | 24471    | 06095      | 30566      | 21 |
| 20 | 9.69456  | 9.93898  | 9.75558  | 10.24441 | 10.06102   | 10.30544   | 20 |
| 19 | 69479    | 93891    | 75588    | 24412    | 06109      | 30521      | 19 |
| 18 | 69501    | 93884    | 75617    | 24383    | 06116      | 30499      | 18 |
| 17 | 69523    | 93876    | 75647    | 24353    | 06124      | 30477      | 17 |
| 16 | 69545    | 93869    | 75676    | 24324    | 06131      | 30455      | 16 |
| 15 | 69567    | 93862    | 75705    | 24295    | 06138      | 30433      | 15 |
| 14 | 69589    | 93855    | 75735    | 24265    | 06145      | 30411      | 14 |
| 13 | 69611    | 93847    | 75764    | 24236    | 06153      | 30389      | 13 |
| 12 | 69633    | 93840    | 75793    | 24207    | 06160      | 30367      | 12 |
| 11 | 69655    | 93833    | 75822    | 24178    | 06167      | 30345      | 11 |
| 10 | 9.69677  | 9.93826  | 9.75852  | 10.24148 | 10.06174   | 10.30323   | 10 |
| 9  | 69699    | 93819    | 75881    | 24119    | 06181      | 30301      | 9  |
| 8  | 69721    | 93811    | 75910    | 24090    | 06189      | 30279      | 8  |
| 7  | 69743    | 93804    | 75939    | 24060    | 06196      | 30256      | 7  |
| 6  | 69765    | 93797    | 75969    | 24031    | 06203      | 30235      | 6  |
| 5  | 69787    | 93789    | 75998    | 24002    | 06210      | 30213      | 5  |
| 4  | 69809    | 93782    | 76027    | 23973    | 06218      | 30191      | 4  |
| 3  | 69831    | 93775    | 76056    | 23944    | 06225      | 30169      | 3  |
| 2  | 69853    | 93768    | 76086    | 23914    | 06232      | 30147      | 2  |
| 1  | 69875    | 93760    | 76115    | 23885    | 06240      | 30125      | 1  |
| 0  | 69897    | 93753    | 76144    | 23856    | 06247      | 30103      | 0  |
| M. | Co-fine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |



TABLE V. OF ARTIFICIAL Sines, Tangents, and Secants. 30 Degree

| M. | Sine.    | Co-fine. | Tangent. | Co-tang.  | Secant.    | Co-secant. |
|----|----------|----------|----------|-----------|------------|------------|
| 0  | 9. 69897 | 9. 93753 | 9. 76144 | 10. 23856 | 10. 06247  | 10. 30103  |
| 1  | 69919    | 93746    | 76173    | 23827     | 06254      | 30081      |
| 2  | 69941    | 93738    | 76202    | 23798     | 06261      | 30059      |
| 3  | 69963    | 93731    | 76231    | 23769     | 06269      | 30037      |
| 4  | 69984    | 93724    | 76261    | 23739     | 06276      | 30016      |
| 5  | 70006    | 93717    | 76290    | 23710     | 06283      | 29994      |
| 6  | 70028    | 93709    | 76319    | 23681     | 06291      | 29972      |
| 7  | 70050    | 93702    | 76348    | 23652     | 06298      | 29950      |
| 8  | 70072    | 93695    | 76377    | 23623     | 06305      | 29928      |
| 9  | 70093    | 93687    | 76406    | 23594     | 06313      | 29907      |
| 10 | 9. 70115 | 9. 93680 | 9. 76435 | 10. 23565 | 10. 06320  | 10. 29885  |
| 11 | 70137    | 93673    | 76464    | 23536     | 06327      | 29864      |
| 12 | 70159    | 93665    | 76493    | 23507     | 06335      | 29841      |
| 13 | 70180    | 93658    | 76522    | 23478     | 06342      | 29820      |
| 14 | 70202    | 93650    | 76551    | 23449     | 06350      | 29798      |
| 15 | 70224    | 93643    | 76580    | 23420     | 06357      | 29776      |
| 16 | 70245    | 93636    | 76609    | 23391     | 06364      | 29755      |
| 17 | 70267    | 93628    | 76639    | 23361     | 06372      | 29733      |
| 18 | 70288    | 93621    | 76668    | 23332     | 06379      | 29712      |
| 19 | 70310    | 93614    | 76697    | 23303     | 06386      | 29690      |
| 20 | 9. 70332 | 9. 93606 | 9. 76725 | 10. 23274 | 10. 06394  | 10. 29668  |
| 21 | 70353    | 93599    | 76754    | 23246     | 06401      | 29647      |
| 22 | 70375    | 93591    | 76783    | 23217     | 06409      | 29625      |
| 23 | 70396    | 93584    | 76812    | 23188     | 06416      | 29604      |
| 24 | 70418    | 93577    | 76841    | 23159     | 06423      | 29582      |
| 25 | 70439    | 93569    | 76870    | 23130     | 06431      | 29561      |
| 26 | 70461    | 93562    | 76899    | 23101     | 06438      | 29539      |
| 27 | 70482    | 93554    | 76928    | 23072     | 06446      | 29518      |
| 28 | 70504    | 93547    | 76957    | 23043     | 06453      | 29496      |
| 29 | 70525    | 93539    | 76986    | 23014     | 06461      | 29475      |
| 30 | 9. 70547 | 9. 93532 | 9. 77015 | 10. 22985 | 10. 06468  | 10. 29453  |
| 31 | 70568    | 93525    | 77044    | 22956     | 06475      | 29432      |
| 32 | 70590    | 93517    | 77073    | 22927     | 06483      | 29410      |
| 33 | 70611    | 93510    | 77101    | 22899     | 06490      | 29389      |
| 34 | 70633    | 93502    | 77130    | 22870     | 06498      | 29367      |
| 35 | 70654    | 93495    | 77159    | 22842     | 06505      | 29346      |
| 36 | 70675    | 93487    | 77188    | 22812     | 06513      | 29325      |
| 37 | 70697    | 93480    | 77217    | 22783     | 06520      | 29303      |
| 38 | 70718    | 93472    | 77246    | 22754     | 06528      | 29282      |
| 39 | 70739    | 93465    | 77274    | 22726     | 06535      | 29261      |
| 40 | 9. 70761 | 9. 93457 | 9. 77303 | 10. 22697 | 10. 06543  | 10. 29239  |
| 41 | 70782    | 93450    | 77332    | 22668     | 06550      | 29218      |
| 42 | 70803    | 93442    | 77361    | 22639     | 06558      | 29197      |
| 43 | 70824    | 93435    | 77390    | 22610     | 06565      | 29175      |
| 44 | 70846    | 93427    | 77418    | 22582     | 06573      | 29154      |
| 45 | 70867    | 93420    | 77447    | 22553     | 06580      | 29133      |
| 46 | 70888    | 93412    | 77476    | 22524     | 06588      | 29112      |
| 47 | 70909    | 93405    | 77505    | 22495     | 06595      | 29091      |
| 48 | 70931    | 93397    | 77533    | 22467     | 06603      | 29069      |
| 49 | 70952    | 93390    | 77562    | 22438     | 06610      | 29048      |
| 50 | 9. 70973 | 9. 93382 | 9. 77591 | 10. 22409 | 10. 06618  | 10. 29027  |
| 51 | 70994    | 93375    | 77619    | 22381     | 06625      | 29006      |
| 52 | 71015    | 93367    | 77648    | 22352     | 06633      | 28985      |
| 53 | 71036    | 93360    | 77677    | 22323     | 06640      | 28964      |
| 54 | 71058    | 93352    | 77705    | 22294     | 06648      | 28942      |
| 55 | 71079    | 93344    | 77734    | 22266     | 06656      | 28921      |
| 56 | 71100    | 93337    | 77763    | 22237     | 06663      | 28900      |
| 57 | 71121    | 93329    | 77791    | 22208     | 06671      | 28879      |
| 58 | 71142    | 93322    | 77820    | 22180     | 06678      | 28858      |
| 59 | 71163    | 93314    | 77849    | 22151     | 06686      | 28837      |
| 60 | 71184    | 93307    | 77877    | 22123     | 06693      | 28816      |
|    | Co-fine. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    |

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 31 Degrees.

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant |    |
|----|----------|----------|----------|----------|------------|-----------|----|
| 0  | 9.71184  | 9.93307  | 9.77877  | 10.22123 | 10.06693   | 10.28816  | 00 |
| 1  | 71205    | 93299    | 77906    | 22094    | 06701      | 28795     | 59 |
| 2  | 71226    | 93291    | 77935    | 22065    | 06709      | 28774     | 58 |
| 3  | 71247    | 93284    | 77963    | 22037    | 06716      | 28753     | 57 |
| 4  | 71268    | 93276    | 77992    | 22008    | 06724      | 28732     | 56 |
| 5  | 71289    | 93269    | 78021    | 21980    | 06731      | 28711     | 55 |
| 6  | 71310    | 93261    | 78049    | 21951    | 06739      | 28690     | 54 |
| 7  | 71331    | 93253    | 78077    | 21923    | 06747      | 28669     | 53 |
| 8  | 71352    | 93246    | 78106    | 21894    | 06754      | 28648     | 52 |
| 9  | 71373    | 93238    | 78135    | 21865    | 06762      | 28627     | 51 |
| 10 | 9.71393  | 9.93230  | 9.78163  | 10.21837 | 10.06770   | 10.28607  | 50 |
| 11 | 71414    | 93223    | 78192    | 21808    | 06777      | 28586     | 49 |
| 12 | 71435    | 93215    | 78220    | 21780    | 06785      | 28565     | 48 |
| 13 | 71456    | 93207    | 78249    | 21751    | 06792      | 28544     | 47 |
| 14 | 71477    | 93200    | 78277    | 21723    | 06800      | 28523     | 46 |
| 15 | 71498    | 93192    | 78306    | 21694    | 06808      | 28502     | 45 |
| 16 | 71519    | 93184    | 78334    | 21666    | 06816      | 28481     | 44 |
| 17 | 71539    | 93177    | 78363    | 21637    | 06823      | 28461     | 43 |
| 18 | 71560    | 93169    | 78391    | 21609    | 06831      | 28440     | 42 |
| 19 | 71581    | 93161    | 78419    | 21580    | 06839      | 28419     | 41 |
| 20 | 9.71602  | 9.93154  | 9.78448  | 10.21552 | 10.06846   | 10.28398  | 40 |
| 21 | 71622    | 93146    | 78476    | 21524    | 06854      | 28378     | 39 |
| 22 | 71643    | 93138    | 78505    | 21495    | 06862      | 28357     | 38 |
| 23 | 71664    | 93131    | 78533    | 21467    | 06869      | 28336     | 37 |
| 24 | 71685    | 93123    | 78562    | 21438    | 06877      | 28315     | 36 |
| 25 | 71705    | 93115    | 78590    | 21410    | 06885      | 28295     | 35 |
| 26 | 71726    | 93107    | 78618    | 21382    | 06893      | 28274     | 34 |
| 27 | 71747    | 93100    | 78647    | 21353    | 06900      | 28253     | 33 |
| 28 | 71767    | 93092    | 78675    | 21325    | 06908      | 28233     | 32 |
| 29 | 71788    | 93084    | 78704    | 21296    | 06916      | 28212     | 31 |
| 30 | 9.71809  | 9.93077  | 9.78732  | 10.21268 | 10.06923   | 10.28191  | 30 |
| 31 | 71829    | 93069    | 78760    | 21240    | 06931      | 28171     | 29 |
| 32 | 71850    | 93061    | 78789    | 21211    | 06939      | 28150     | 28 |
| 33 | 71870    | 93053    | 78817    | 21183    | 06947      | 28130     | 27 |
| 34 | 71891    | 93046    | 78845    | 21155    | 06954      | 28109     | 26 |
| 35 | 71911    | 93038    | 78874    | 21126    | 06962      | 28089     | 25 |
| 36 | 71932    | 93030    | 78902    | 21098    | 06970      | 28068     | 24 |
| 37 | 71952    | 93022    | 78930    | 21070    | 06978      | 28048     | 23 |
| 38 | 71973    | 93014    | 78959    | 21041    | 06985      | 28027     | 22 |
| 39 | 71993    | 93007    | 78987    | 21013    | 06993      | 28007     | 21 |
| 40 | 9.72014  | 9.92999  | 9.79015  | 10.20985 | 10.07001   | 10.27986  | 20 |
| 41 | 72034    | 92991    | 79043    | 20957    | 07009      | 27965     | 19 |
| 42 | 72055    | 92983    | 79072    | 20928    | 07017      | 27945     | 18 |
| 43 | 72075    | 92975    | 79100    | 20900    | 07024      | 27925     | 17 |
| 44 | 72096    | 92968    | 79128    | 20872    | 07032      | 27904     | 16 |
| 45 | 72116    | 92960    | 79156    | 20844    | 07040      | 27884     | 15 |
| 46 | 72137    | 92952    | 79185    | 20815    | 07048      | 27863     | 14 |
| 47 | 72157    | 92944    | 79213    | 20787    | 07056      | 27843     | 13 |
| 48 | 72177    | 92936    | 79241    | 20759    | 07064      | 27823     | 12 |
| 49 | 72198    | 92929    | 79269    | 20731    | 07071      | 27802     | 11 |
| 50 | 9.72218  | 9.92921  | 9.79297  | 10.20703 | 10.07079   | 10.27782  | 10 |
| 51 | 72238    | 92913    | 79326    | 20674    | 07087      | 27761     | 9  |
| 52 | 72259    | 92905    | 79354    | 20646    | 07095      | 27741     | 8  |
| 53 | 72279    | 92897    | 79382    | 20618    | 07103      | 27721     | 7  |
| 54 | 72299    | 92889    | 79410    | 20590    | 07111      | 27701     | 6  |
| 55 | 72320    | 92881    | 79438    | 20562    | 07119      | 27680     | 5  |
| 56 | 72340    | 92874    | 79466    | 20534    | 07126      | 27660     | 4  |
| 57 | 72360    | 92866    | 79495    | 20505    | 07134      | 27640     | 3  |
| 58 | 72381    | 92858    | 79523    | 20477    | 07142      | 27619     | 2  |
| 59 | 72401    | 92850    | 79551    | 20449    | 07150      | 27599     | 1  |
| 60 | 72421    | 92842    | 79579    | 20421    | 07158      | 27579     | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.   | M. |

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 32. Degree

| M. | Sine.    | Co-sine. | Tangent. | Co-tang.  | Secant.    | Co-secant. |    |
|----|----------|----------|----------|-----------|------------|------------|----|
| 0  | 9. 72431 | 9. 92842 | 9. 79579 | 10. 20421 | 10. 07158  | 10. 27579  | 60 |
| 1  | 72441    | 92834    | 79607    | 20393     | 07166      | 27559      | 59 |
| 2  | 72461    | 92826    | 79635    | 20365     | 07174      | 27539      | 58 |
| 3  | 72482    | 92818    | 79663    | 20337     | 07182      | 27518      | 57 |
| 4  | 72502    | 92810    | 79691    | 20309     | 07190      | 27498      | 56 |
| 5  | 72522    | 92803    | 79719    | 20281     | 07197      | 27478      | 55 |
| 6  | 72542    | 92795    | 79747    | 20253     | 07205      | 27458      | 54 |
| 7  | 72562    | 92787    | 79776    | 20224     | 07213      | 27438      | 53 |
| 8  | 72582    | 92779    | 79804    | 20196     | 07221      | 27418      | 52 |
| 9  | 72602    | 92771    | 79832    | 20168     | 07229      | 27398      | 51 |
| 10 | 9. 72622 | 9. 92763 | 9. 79860 | 10. 20140 | 10. 07237  | 10. 27378  | 50 |
| 11 | 72643    | 92755    | 79888    | 20112     | 07245      | 27357      | 49 |
| 12 | 72663    | 92747    | 79916    | 20084     | 07253      | 27337      | 48 |
| 13 | 72683    | 92739    | 79944    | 20056     | 07261      | 27317      | 47 |
| 14 | 72703    | 92731    | 79972    | 20028     | 07269      | 27297      | 46 |
| 15 | 72723    | 92723    | 80000    | 20000     | 07277      | 27277      | 45 |
| 16 | 72743    | 92715    | 80028    | 19972     | 07285      | 27257      | 44 |
| 17 | 72763    | 92707    | 80056    | 19944     | 07293      | 27237      | 43 |
| 18 | 72783    | 92699    | 80084    | 19916     | 07301      | 27217      | 42 |
| 19 | 72803    | 92691    | 80112    | 19888     | 07309      | 27197      | 41 |
| 20 | 9. 72823 | 9. 92683 | 9. 80140 | 10. 19860 | 10. 07317  | 10. 27177  | 40 |
| 21 | 72843    | 92675    | 80168    | 19832     | 07325      | 27157      | 39 |
| 22 | 72863    | 92667    | 80195    | 19805     | 07333      | 27137      | 38 |
| 23 | 72883    | 92659    | 80223    | 19778     | 07341      | 27117      | 37 |
| 24 | 72902    | 92651    | 80251    | 19749     | 07349      | 27098      | 36 |
| 25 | 72922    | 92643    | 80279    | 19721     | 07357      | 27078      | 35 |
| 26 | 72942    | 92635    | 80307    | 19693     | 07365      | 27058      | 34 |
| 27 | 72962    | 92627    | 80335    | 19665     | 07373      | 27038      | 33 |
| 28 | 72982    | 92619    | 80363    | 19637     | 07381      | 27018      | 32 |
| 29 | 73002    | 92611    | 80391    | 19609     | 07389      | 26998      | 31 |
| 30 | 9. 73022 | 9. 92603 | 9. 80419 | 10. 19581 | 10. 07397  | 10. 26978  | 30 |
| 31 | 73041    | 92595    | 80447    | 19553     | 07405      | 26959      | 29 |
| 32 | 73061    | 92587    | 80474    | 19526     | 07413      | 26939      | 28 |
| 33 | 73081    | 92579    | 80502    | 19498     | 07421      | 26919      | 27 |
| 34 | 73101    | 92571    | 80530    | 19470     | 07429      | 26899      | 26 |
| 35 | 73121    | 92563    | 80558    | 19442     | 07437      | 26879      | 25 |
| 36 | 73140    | 92556    | 80585    | 19414     | 07445      | 26860      | 24 |
| 37 | 73160    | 92548    | 80614    | 19386     | 07454      | 26840      | 23 |
| 38 | 73180    | 92538    | 80642    | 19358     | 07462      | 26820      | 22 |
| 39 | 73200    | 92530    | 80669    | 19331     | 07470      | 26800      | 21 |
| 40 | 9. 73219 | 9. 92522 | 9. 80697 | 10. 19303 | 10. 07478  | 10. 26781  | 20 |
| 41 | 73239    | 92514    | 80725    | 19275     | 07486      | 26761      | 19 |
| 42 | 73259    | 92506    | 80753    | 19247     | 07494      | 26741      | 18 |
| 43 | 73278    | 92498    | 80781    | 19219     | 07502      | 26722      | 17 |
| 44 | 73298    | 92490    | 80808    | 19192     | 07510      | 26702      | 16 |
| 45 | 73318    | 92482    | 80836    | 19164     | 07518      | 26682      | 15 |
| 46 | 73337    | 92473    | 80864    | 19136     | 07527      | 26663      | 14 |
| 47 | 73357    | 92465    | 80892    | 19108     | 07535      | 26643      | 13 |
| 48 | 73377    | 92457    | 80919    | 19081     | 07543      | 26623      | 12 |
| 49 | 73396    | 92449    | 80947    | 19053     | 07551      | 26604      | 11 |
| 50 | 9. 73416 | 9. 92441 | 9. 80975 | 10. 19025 | 10. 07559  | 10. 26584  | 10 |
| 51 | 73435    | 92433    | 81003    | 18997     | 07567      | 26565      | 9  |
| 52 | 73455    | 92425    | 81030    | 18970     | 07575      | 26545      | 8  |
| 53 | 73474    | 92416    | 81058    | 18942     | 07584      | 26526      | 7  |
| 54 | 73494    | 92408    | 81086    | 18914     | 07592      | 26506      | 6  |
| 55 | 73513    | 92400    | 81113    | 18887     | 07600      | 26487      | 5  |
| 56 | 73533    | 92392    | 81141    | 18859     | 07608      | 26467      | 4  |
| 57 | 73552    | 92384    | 81169    | 18831     | 07616      | 26448      | 3  |
| 58 | 73572    | 92376    | 81196    | 18804     | 07624      | 26428      | 2  |
| 59 | 73591    | 92367    | 81224    | 18776     | 07633      | 26409      | 1  |
| 60 | 73611    | 92359    | 81252    | 18748     | 07641      | 26389      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    | M  |

57 Degrees.



TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 33 Degrees.

|    | M. | Sine.    | Co-sine. | Tangent. | Co-tang. | -Secant.   | Co-secant. |    |
|----|----|----------|----------|----------|----------|------------|------------|----|
| 60 | 0  | 9.73611  | 9.92359  | 9.81252  | 10.18748 | 10.07641   | 10.26389   | 60 |
| 59 | 1  | 73630    | 92351    | 81279    | 18721    | 07649      | 26370      | 59 |
| 58 | 2  | 73650    | 92343    | 81307    | 18693    | 07657      | 26350      | 58 |
| 57 | 3  | 73669    | 92334    | 81335    | 18665    | 07666      | 26331      | 57 |
| 56 | 4  | 73689    | 92326    | 81362    | 18638    | 07674      | 26311      | 56 |
| 55 | 5  | 73708    | 92318    | 81390    | 18610    | 07682      | 26292      | 55 |
| 54 | 6  | 73727    | 92310    | 81417    | 18582    | 07690      | 26273      | 54 |
| 53 | 7  | 73747    | 92302    | 81445    | 18555    | 07698      | 26253      | 53 |
| 52 | 8  | 73766    | 92293    | 81473    | 18527    | 07707      | 26234      | 52 |
| 51 | 9  | 73785    | 92285    | 81500    | 18500    | 07715      | 26215      | 51 |
| 50 | 10 | 9.73805  | 9.92277  | 9.81528  | 10.18472 | 10.07723   | 10.26195   | 50 |
| 49 | 11 | 73824    | 92269    | 81556    | 18444    | 07731      | 26176      | 49 |
| 48 | 12 | 73843    | 92260    | 81583    | 18417    | 07740      | 26157      | 48 |
| 47 | 13 | 73863    | 92252    | 81611    | 18389    | 07748      | 26137      | 47 |
| 46 | 14 | 73882    | 92244    | 81638    | 18362    | 07756      | 26118      | 46 |
| 45 | 15 | 73901    | 92235    | 81666    | 18334    | 07765      | 26099      | 45 |
| 44 | 16 | 73921    | 92227    | 81693    | 18307    | 07773      | 26079      | 44 |
| 43 | 17 | 73940    | 92219    | 81721    | 18279    | 07781      | 26060      | 43 |
| 42 | 18 | 73959    | 92211    | 81748    | 18252    | 07789      | 26041      | 42 |
| 41 | 19 | 73978    | 92202    | 81776    | 18224    | 07798      | 26022      | 41 |
| 40 | 20 | 9.73997  | 9.92194  | 9.81803  | 10.18197 | 10.07806   | 10.26002   | 40 |
| 39 | 21 | 74017    | 92186    | 81831    | 18169    | 07814      | 25983      | 39 |
| 38 | 22 | 74036    | 92177    | 81858    | 18142    | 07823      | 25964      | 38 |
| 37 | 23 | 74055    | 92169    | 81886    | 18114    | 07831      | 25945      | 37 |
| 36 | 24 | 74074    | 92161    | 81913    | 18087    | 07839      | 25926      | 36 |
| 35 | 25 | 74093    | 92152    | 81941    | 18059    | 07848      | 25907      | 35 |
| 34 | 26 | 74112    | 92144    | 81968    | 18032    | 07856      | 25887      | 34 |
| 33 | 27 | 74132    | 92136    | 81996    | 18004    | 07864      | 25868      | 33 |
| 32 | 28 | 74151    | 92127    | 82023    | 17977    | 07873      | 25849      | 32 |
| 31 | 29 | 74170    | 92119    | 82051    | 17949    | 07881      | 25830      | 31 |
| 30 | 30 | 9.74189  | 9.92111  | 9.82078  | 10.17922 | 10.07889   | 10.25811   | 30 |
| 29 | 31 | 74208    | 92102    | 82106    | 17894    | 07898      | 25792      | 29 |
| 28 | 32 | 74227    | 92094    | 82133    | 17867    | 07906      | 25773      | 28 |
| 27 | 33 | 74246    | 92086    | 82161    | 17839    | 07914      | 25754      | 27 |
| 26 | 34 | 74265    | 92077    | 82188    | 17812    | 07923      | 25735      | 26 |
| 25 | 35 | 74284    | 92069    | 82215    | 17784    | 07931      | 25716      | 25 |
| 24 | 36 | 74303    | 92060    | 82243    | 17757    | 07940      | 25697      | 24 |
| 23 | 37 | 74322    | 92052    | 82270    | 17730    | 07948      | 25678      | 23 |
| 22 | 38 | 74341    | 92044    | 82298    | 17702    | 07956      | 25659      | 22 |
| 21 | 39 | 74360    | 92035    | 82325    | 17675    | 07965      | 25640      | 21 |
| 20 | 40 | 9.74379  | 9.92027  | 9.82352  | 10.17648 | 10.07973   | 10.25621   | 20 |
| 19 | 41 | 74398    | 92018    | 82380    | 17620    | 07982      | 25602      | 19 |
| 18 | 42 | 74417    | 92010    | 82407    | 17593    | 07990      | 25583      | 18 |
| 17 | 43 | 74436    | 92002    | 82434    | 17565    | 07998      | 25564      | 17 |
| 16 | 44 | 74455    | 91993    | 82462    | 17538    | 08007      | 25545      | 16 |
| 15 | 45 | 74474    | 91985    | 82489    | 17511    | 08015      | 25526      | 15 |
| 14 | 46 | 74493    | 91976    | 82517    | 17483    | 08024      | 25507      | 14 |
| 13 | 47 | 74512    | 91968    | 82544    | 17456    | 08032      | 25488      | 13 |
| 12 | 48 | 74531    | 91959    | 82571    | 17429    | 08041      | 25469      | 12 |
| 11 | 49 | 74549    | 91951    | 82599    | 17401    | 08049      | 25451      | 11 |
| 10 | 50 | 9.74568  | 9.91942  | 9.82626  | 10.17374 | 10.08058   | 10.25432   | 10 |
| 9  | 51 | 74587    | 91934    | 82653    | 17347    | 08066      | 25413      | 9  |
| 8  | 52 | 74606    | 91925    | 82681    | 17319    | 08075      | 25394      | 8  |
| 7  | 53 | 74625    | 91917    | 82708    | 17292    | 08083      | 25375      | 7  |
| 6  | 54 | 74644    | 91908    | 82735    | 17265    | 08092      | 25356      | 6  |
| 5  | 55 | 74662    | 91900    | 82762    | 17238    | 08100      | 25338      | 5  |
| 4  | 56 | 74681    | 91891    | 82790    | 17210    | 08109      | 25319      | 4  |
| 3  | 57 | 74700    | 91883    | 82817    | 17183    | 08117      | 25300      | 3  |
| 2  | 58 | 74719    | 91874    | 82844    | 17156    | 08126      | 25281      | 2  |
| 1  | 59 | 74737    | 91866    | 82871    | 17129    | 08134      | 25263      | 1  |
| 0  | 60 | 74756    | 91857    | 82899    | 17101    | 08143      | 25244      | 0  |
| M  |    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |

56 Degrees.

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 34 Degrees

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 9.74736  | 9.91857  | 9.82899  | 10.17101 | 10.08143   | 10.25244   | 60 |
| 1  | 74775    | 91849    | 82926    | 17074    | 08151      | 25225      | 59 |
| 2  | 74794    | 91840    | 82953    | 17047    | 08160      | 25206      | 58 |
| 3  | 74812    | 91832    | 82980    | 17020    | 08168      | 25188      | 57 |
| 4  | 74831    | 91823    | 83008    | 16992    | 08177      | 25169      | 56 |
| 5  | 74850    | 91815    | 83035    | 16965    | 08185      | 25150      | 55 |
| 6  | 74868    | 91806    | 83062    | 16938    | 08194      | 25132      | 54 |
| 7  | 74887    | 91798    | 83089    | 16911    | 08202      | 25113      | 53 |
| 8  | 74906    | 91789    | 83116    | 16883    | 08211      | 25094      | 52 |
| 9  | 74924    | 91780    | 83144    | 16856    | 08219      | 25076      | 51 |
| 10 | 9.74943  | 9.91772  | 9.83171  | 10.16829 | 10.08228   | 10.25057   | 50 |
| 11 | 74961    | 91763    | 83198    | 16802    | 08237      | 25039      | 49 |
| 12 | 74980    | 91755    | 83225    | 16775    | 08245      | 25020      | 48 |
| 13 | 74999    | 91746    | 83252    | 16748    | 08254      | 25001      | 47 |
| 14 | 75017    | 91738    | 83279    | 16720    | 08262      | 24983      | 46 |
| 15 | 75036    | 91729    | 83307    | 16693    | 08271      | 24964      | 45 |
| 16 | 75054    | 91720    | 83334    | 16666    | 08280      | 24946      | 44 |
| 17 | 75073    | 91712    | 83361    | 16639    | 08288      | 24927      | 43 |
| 18 | 75091    | 91703    | 83388    | 16612    | 08297      | 24909      | 42 |
| 19 | 75110    | 91694    | 83415    | 16585    | 08305      | 24890      | 41 |
| 20 | 9.75128  | 9.91686  | 9.83442  | 10.16558 | 10.08314   | 10.24872   | 40 |
| 21 | 75147    | 91677    | 83470    | 16530    | 08323      | 24853      | 39 |
| 22 | 75165    | 91668    | 83497    | 16503    | 08331      | 24835      | 38 |
| 23 | 75184    | 91660    | 83524    | 16476    | 08340      | 24816      | 37 |
| 24 | 75202    | 91651    | 83551    | 16449    | 08349      | 24798      | 36 |
| 25 | 75221    | 91643    | 83578    | 16422    | 08357      | 24779      | 35 |
| 26 | 75239    | 91634    | 83605    | 16395    | 08366      | 24761      | 34 |
| 27 | 75258    | 91625    | 83632    | 16368    | 08375      | 24742      | 33 |
| 28 | 75276    | 91617    | 83659    | 16341    | 08383      | 24724      | 32 |
| 29 | 75294    | 91608    | 83686    | 16314    | 08392      | 24706      | 31 |
| 30 | 9.75313  | 9.91599  | 9.83713  | 10.16287 | 10.08401   | 10.24687   | 30 |
| 31 | 75331    | 91591    | 83740    | 16260    | 08409      | 24669      | 29 |
| 32 | 75349    | 91582    | 83767    | 16232    | 08418      | 24650      | 28 |
| 33 | 75368    | 91573    | 83795    | 16205    | 08427      | 24632      | 27 |
| 34 | 75386    | 91565    | 83822    | 16178    | 08435      | 24614      | 26 |
| 35 | 75405    | 91556    | 83849    | 16151    | 08444      | 24595      | 25 |
| 36 | 75423    | 91547    | 83876    | 16124    | 08453      | 24577      | 24 |
| 37 | 75441    | 91538    | 83903    | 16097    | 08462      | 24559      | 23 |
| 38 | 75459    | 91530    | 83930    | 16070    | 08470      | 24541      | 22 |
| 39 | 75478    | 91521    | 83957    | 16043    | 08479      | 24522      | 21 |
| 40 | 9.75496  | 9.91512  | 9.83984  | 10.16016 | 10.08488   | 10.24504   | 20 |
| 41 | 75514    | 91503    | 84011    | 15989    | 08496      | 24486      | 19 |
| 42 | 75533    | 91495    | 84038    | 15962    | 08505      | 24467      | 18 |
| 43 | 75551    | 91486    | 84065    | 15935    | 08514      | 24449      | 17 |
| 44 | 75569    | 91477    | 84092    | 15908    | 08523      | 24431      | 16 |
| 45 | 75587    | 91468    | 84119    | 15881    | 08531      | 24413      | 15 |
| 46 | 75605    | 91460    | 84146    | 15854    | 08540      | 24395      | 14 |
| 47 | 75624    | 91451    | 84173    | 15827    | 08549      | 24376      | 13 |
| 48 | 75642    | 91442    | 84200    | 15800    | 08558      | 24358      | 12 |
| 49 | 75660    | 91433    | 84227    | 15773    | 08567      | 24340      | 11 |
| 50 | 9.75678  | 9.91425  | 9.84254  | 10.15746 | 10.08575   | 10.24322   | 10 |
| 51 | 75696    | 91416    | 84280    | 15720    | 08584      | 24304      | 9  |
| 52 | 75714    | 91407    | 84307    | 15693    | 08593      | 24286      | 8  |
| 53 | 75732    | 91398    | 84334    | 15666    | 08602      | 24267      | 7  |
| 54 | 75751    | 91389    | 84361    | 15639    | 08611      | 24249      | 6  |
| 55 | 75769    | 91381    | 84388    | 15612    | 08619      | 24231      | 5  |
| 56 | 75787    | 91372    | 84415    | 15585    | 08628      | 24213      | 4  |
| 57 | 75805    | 91363    | 84442    | 15558    | 08637      | 24195      | 3  |
| 58 | 75823    | 91354    | 84469    | 15531    | 08646      | 24177      | 2  |
| 59 | 75841    | 91345    | 84496    | 15504    | 08655      | 24159      | 1  |
| 60 | 75859    | 91336    | 84523    | 15477    | 08664      | 24141      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |

55 Degrees.

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 35 Degrees.

| M.       | Sine.   | Co-sine. | Tangent. | Co-tang.   | Secant.  | Co-secant. |    |
|----------|---------|----------|----------|------------|----------|------------|----|
| 0        | 9.75859 | 9.91336  | 9.84523  | 10.15477   | 10.08664 | 10.24141   | 60 |
| 1        | 75877   | 91328    | 84550    | 15450      | 08672    | 24123      | 59 |
| 2        | 75895   | 91319    | 84576    | 15424      | 08681    | 24105      | 58 |
| 3        | 75913   | 91310    | 84603    | 15397      | 08690    | 24087      | 57 |
| 4        | 75931   | 91301    | 84630    | 15370      | 08699    | 24069      | 56 |
| 5        | 75949   | 91292    | 84657    | 15343      | 08708    | 24051      | 55 |
| 6        | 75967   | 91283    | 84684    | 15316      | 08717    | 24033      | 54 |
| 7        | 75985   | 91274    | 84711    | 15289      | 08726    | 24015      | 53 |
| 8        | 76003   | 91267    | 84738    | 15262      | 08734    | 23997      | 52 |
| 9        | 76021   | 91257    | 84764    | 15236      | 08743    | 23979      | 51 |
| 10       | 9.76039 | 9.91248  | 9.84791  | 10.15209   | 10.08752 | 10.23961   | 50 |
| 11       | 76057   | 91239    | 84818    | 15182      | 08761    | 23943      | 49 |
| 12       | 76075   | 91230    | 84845    | 15155      | 08770    | 23925      | 48 |
| 13       | 76093   | 91221    | 84872    | 15128      | 08779    | 23907      | 47 |
| 14       | 76111   | 91212    | 84899    | 15101      | 08788    | 23889      | 46 |
| 15       | 76129   | 91203    | 84925    | 15075      | 08797    | 23871      | 45 |
| 16       | 76146   | 91194    | 84952    | 15048      | 08806    | 23854      | 44 |
| 17       | 76164   | 91185    | 84979    | 15021      | 08815    | 23836      | 43 |
| 18       | 76182   | 91176    | 85006    | 14994      | 08824    | 23818      | 42 |
| 19       | 76200   | 91167    | 85033    | 14967      | 08833    | 23800      | 41 |
| 20       | 9.76218 | 9.91158  | 9.85059  | 10.14941   | 10.08842 | 10.23782   | 40 |
| 21       | 76236   | 91149    | 85086    | 14914      | 08851    | 23764      | 39 |
| 22       | 76253   | 91141    | 85113    | 14887      | 08859    | 23747      | 38 |
| 23       | 76271   | 91132    | 85140    | 14860      | 08868    | 23729      | 37 |
| 24       | 76289   | 91123    | 85166    | 14834      | 08877    | 23711      | 36 |
| 25       | 76307   | 91114    | 85193    | 14807      | 08886    | 23693      | 35 |
| 26       | 76324   | 91105    | 85220    | 14780      | 08895    | 23676      | 34 |
| 27       | 76342   | 91096    | 85247    | 14753      | 08904    | 23658      | 33 |
| 28       | 76360   | 91087    | 85273    | 14727      | 08913    | 23640      | 32 |
| 29       | 76378   | 91078    | 85300    | 14700      | 08922    | 23622      | 31 |
| 30       | 9.76395 | 9.91069  | 9.85327  | 10.14673   | 10.08931 | 10.23605   | 30 |
| 31       | 76413   | 91090    | 85354    | 14646      | 08940    | 23587      | 29 |
| 32       | 76431   | 91051    | 85380    | 14620      | 08949    | 23569      | 28 |
| 33       | 76448   | 91042    | 85407    | 14593      | 08958    | 23552      | 27 |
| 34       | 76466   | 91034    | 85434    | 14566      | 08966    | 23534      | 26 |
| 35       | 76484   | 91023    | 85460    | 14540      | 08977    | 23516      | 25 |
| 36       | 76501   | 91014    | 85487    | 14513      | 08987    | 23499      | 24 |
| 37       | 76519   | 91005    | 85514    | 14486      | 08995    | 23481      | 23 |
| 38       | 76537   | 90996    | 85540    | 14460      | 09004    | 23463      | 22 |
| 39       | 76554   | 90987    | 85567    | 14433      | 09013    | 23446      | 21 |
| 40       | 9.76572 | 9.90978  | 9.85594  | 10.14406   | 10.09022 | 10.23428   | 20 |
| 41       | 76590   | 90969    | 85620    | 14380      | 09031    | 23410      | 19 |
| 42       | 76607   | 90960    | 85647    | 14353      | 09040    | 23393      | 18 |
| 43       | 76625   | 90951    | 85674    | 14326      | 09049    | 23375      | 17 |
| 44       | 76642   | 90942    | 85700    | 14300      | 09058    | 23358      | 16 |
| 45       | 76660   | 90933    | 85727    | 14273      | 09067    | 23340      | 15 |
| 46       | 76677   | 90924    | 85754    | 14246      | 09076    | 23323      | 14 |
| 47       | 76695   | 90915    | 85780    | 14220      | 09085    | 23305      | 13 |
| 48       | 76712   | 90905    | 85807    | 14193      | 09095    | 23288      | 12 |
| 49       | 76730   | 90896    | 85834    | 14166      | 09104    | 23270      | 11 |
| 50       | 9.76747 | 9.90887  | 9.85860  | 10.14140   | 10.09113 | 10.23253   | 10 |
| 51       | 76765   | 90878    | 85887    | 14113      | 09122    | 23235      | 9  |
| 52       | 76782   | 90869    | 85913    | 14087      | 09131    | 23218      | 8  |
| 53       | 76800   | 90860    | 85940    | 14060      | 09140    | 23200      | 7  |
| 54       | 76817   | 90851    | 85967    | 14033      | 09149    | 23183      | 6  |
| 55       | 76835   | 90842    | 85993    | 14007      | 09158    | 23165      | 5  |
| 56       | 76852   | 90832    | 86020    | 13980      | 09168    | 23148      | 4  |
| 57       | 76870   | 90823    | 86046    | 13954      | 09177    | 23130      | 3  |
| 58       | 76887   | 90814    | 86073    | 13927      | 09186    | 23113      | 2  |
| 59       | 76904   | 90805    | 86100    | 13900      | 09195    | 23096      | 1  |
| 60       | 76922   | 90796    | 86126    | 13874      | 09204    | 23078      | 0  |
| Co-sine. | Sine.   | Co-tang. | Tangent. | Co-secant. | Secant.  | M.         |    |

54 Degrees.



TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 36 Degrees.

| M.       | Sine.   | Co-line. | Tangent. | Co-tang.   | Secant.  | Co-secant. |    |
|----------|---------|----------|----------|------------|----------|------------|----|
| 0        | 9.76922 | 9.90796  | 9.86126  | 10.13874   | 10.09204 | 10.23078   | 60 |
| 1        | 76939   | 90787    | 86153    | 13847      | 09213    | 23061      | 59 |
| 2        | 76957   | 90777    | 86179    | 13821      | 09223    | 23043      | 58 |
| 3        | 76974   | 90768    | 86206    | 13794      | 09232    | 23026      | 57 |
| 4        | 76991   | 90759    | 86232    | 13768      | 09241    | 23009      | 56 |
| 5        | 77009   | 90750    | 86259    | 13741      | 09250    | 22991      | 55 |
| 6        | 77026   | 90741    | 86285    | 13715      | 09259    | 22974      | 54 |
| 7        | 77043   | 90731    | 86312    | 13688      | 09269    | 22957      | 53 |
| 8        | 77061   | 90722    | 86338    | 13662      | 09278    | 22939      | 52 |
| 9        | 77078   | 90713    | 86365    | 13635      | 09287    | 22922      | 51 |
| 10       | 9.77095 | 9.90704  | 9.86392  | 10.13608   | 10.09296 | 10.22905   | 50 |
| 11       | 77112   | 90694    | 86418    | 13582      | 09306    | 22888      | 49 |
| 12       | 77130   | 90585    | 86445    | 13555      | 09315    | 22870      | 48 |
| 13       | 77147   | 90676    | 86471    | 13529      | 09324    | 22853      | 47 |
| 14       | 77164   | 90667    | 86498    | 13502      | 09333    | 22836      | 46 |
| 15       | 77181   | 90657    | 86524    | 13476      | 09343    | 22819      | 45 |
| 16       | 77199   | 90648    | 86551    | 13449      | 09352    | 22801      | 44 |
| 17       | 77216   | 90639    | 86577    | 13423      | 09361    | 22784      | 43 |
| 18       | 77233   | 90630    | 86603    | 13397      | 09370    | 22767      | 42 |
| 19       | 77250   | 90620    | 86630    | 13370      | 09380    | 22750      | 41 |
| 20       | 9.77268 | 9.90611  | 9.86655  | 10.13344   | 10.09389 | 10.22732   | 40 |
| 21       | 77285   | 90602    | 86683    | 13317      | 09398    | 22715      | 39 |
| 22       | 77302   | 90592    | 86709    | 13291      | 09408    | 22698      | 38 |
| 23       | 77319   | 90583    | 86736    | 13264      | 09417    | 22681      | 37 |
| 24       | 77336   | 90574    | 86762    | 13238      | 09426    | 22664      | 36 |
| 25       | 77353   | 90565    | 86789    | 13211      | 09435    | 22647      | 35 |
| 26       | 77370   | 90555    | 86815    | 13185      | 09445    | 22630      | 34 |
| 27       | 77387   | 90546    | 86842    | 13158      | 09454    | 22613      | 33 |
| 28       | 77405   | 90537    | 86868    | 13132      | 09463    | 22595      | 32 |
| 29       | 77422   | 90527    | 86894    | 13106      | 09473    | 22578      | 31 |
| 30       | 9.77439 | 9.90518  | 9.86921  | 10.13079   | 10.09482 | 10.22561   | 30 |
| 31       | 77456   | 90509    | 86947    | 13053      | 09491    | 22544      | 29 |
| 32       | 77473   | 90499    | 86974    | 13026      | 09501    | 22527      | 28 |
| 33       | 77490   | 90490    | 87000    | 13000      | 09510    | 22510      | 27 |
| 34       | 77507   | 90480    | 87027    | 12973      | 09520    | 22493      | 26 |
| 35       | 77524   | 90471    | 87053    | 12947      | 09529    | 22476      | 25 |
| 36       | 77541   | 90462    | 87079    | 12921      | 09538    | 22459      | 24 |
| 37       | 77558   | 90453    | 87106    | 12894      | 09548    | 22442      | 23 |
| 38       | 77575   | 90443    | 87132    | 12868      | 09557    | 22425      | 22 |
| 39       | 77592   | 90434    | 87158    | 12842      | 09566    | 22408      | 21 |
| 40       | 9.77609 | 9.90424  | 9.87185  | 10.12815   | 10.09576 | 10.22391   | 20 |
| 41       | 77626   | 90415    | 87211    | 12789      | 09585    | 22374      | 19 |
| 42       | 77643   | 90405    | 87238    | 12762      | 09595    | 22357      | 18 |
| 43       | 77660   | 90396    | 87264    | 12736      | 09604    | 22340      | 17 |
| 44       | 77677   | 90386    | 87290    | 12710      | 09613    | 22324      | 16 |
| 45       | 77694   | 90377    | 87317    | 12683      | 09623    | 22306      | 15 |
| 46       | 77711   | 90368    | 87343    | 12657      | 09632    | 22289      | 14 |
| 47       | 77727   | 90358    | 87369    | 12631      | 09642    | 22272      | 13 |
| 48       | 77744   | 90349    | 87396    | 12604      | 09651    | 22256      | 12 |
| 49       | 77761   | 90339    | 87422    | 12578      | 09661    | 22239      | 11 |
| 50       | 9.77778 | 9.90330  | 9.87448  | 10.12552   | 10.09670 | 10.22222   | 10 |
| 51       | 77795   | 90320    | 87475    | 12525      | 09680    | 22205      | 9  |
| 52       | 77812   | 90311    | 87501    | 12499      | 09689    | 22188      | 8  |
| 53       | 77829   | 90301    | 87527    | 12473      | 09699    | 22171      | 7  |
| 54       | 77846   | 90292    | 87554    | 12446      | 09708    | 22154      | 6  |
| 55       | 77862   | 90282    | 87580    | 12420      | 09718    | 22138      | 5  |
| 56       | 77879   | 90273    | 87606    | 12394      | 09727    | 22121      | 4  |
| 57       | 77896   | 90263    | 87633    | 12367      | 09737    | 22104      | 3  |
| 58       | 77913   | 90254    | 87659    | 12341      | 09746    | 22087      | 2  |
| 59       | 77930   | 90244    | 87685    | 12315      | 09756    | 22070      | 1  |
| 60       | 77946   | 90235    | 87711    | 12289      | 09765    | 22054      | 0  |
| Co-line. | Sine.   | Co-tang. | Tangent. | Co-secant. | Secant.  | M.         |    |

53 Degrees.

TABLE

| M. |  |
|----|--|
| 0  |  |
| 1  |  |
| 2  |  |
| 3  |  |
| 4  |  |
| 5  |  |
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TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 37 Degrees.

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 9.77946  | 9.90235  | 9.87711  | 10.12289 | 10.09765   | 10.22054   | 60 |
| 1  | 77963    | 90225    | 87738    | 12262    | 09775      | 22037      | 59 |
| 2  | 77980    | 90216    | 87764    | 12236    | 09784      | 22020      | 58 |
| 3  | 77997    | 90206    | 87790    | 12210    | 09794      | 22003      | 57 |
| 4  | 78013    | 90197    | 87817    | 12183    | 09803      | 21987      | 56 |
| 5  | 78030    | 90187    | 87843    | 12157    | 09813      | 21970      | 55 |
| 6  | 78047    | 90178    | 87869    | 12131    | 09822      | 21953      | 54 |
| 7  | 78063    | 90168    | 87895    | 12105    | 09832      | 21937      | 53 |
| 8  | 78080    | 90159    | 87922    | 12078    | 09841      | 21920      | 52 |
| 9  | 78097    | 90149    | 87948    | 12052    | 09851      | 21903      | 51 |
| 10 | 9.78113  | 9.90139  | 9.87974  | 10.12026 | 10.09861   | 10.21887   | 50 |
| 11 | 78130    | 90130    | 88000    | 12000    | 09870      | 21870      | 49 |
| 12 | 78147    | 90120    | 88027    | 11973    | 09880      | 21853      | 48 |
| 13 | 78163    | 90111    | 88053    | 11947    | 09889      | 21837      | 47 |
| 14 | 78180    | 90101    | 88079    | 11921    | 09899      | 21820      | 46 |
| 15 | 78197    | 90091    | 88105    | 11895    | 09909      | 21803      | 45 |
| 16 | 78213    | 90082    | 88131    | 11869    | 09918      | 21787      | 44 |
| 17 | 78230    | 90072    | 88158    | 11842    | 09928      | 21770      | 43 |
| 18 | 78246    | 90063    | 88184    | 11816    | 09937      | 21754      | 42 |
| 19 | 78263    | 90053    | 88210    | 11790    | 09947      | 21737      | 41 |
| 20 | 9.78280  | 9.90043  | 9.88236  | 10.11764 | 10.09957   | 10.21720   | 40 |
| 21 | 78296    | 90034    | 88262    | 11738    | 09966      | 21704      | 39 |
| 22 | 78313    | 90024    | 88289    | 11711    | 09976      | 21687      | 38 |
| 23 | 78329    | 90014    | 88315    | 11685    | 09986      | 21671      | 37 |
| 24 | 78346    | 90005    | 88341    | 11659    | 09995      | 21654      | 36 |
| 25 | 78362    | 89995    | 88367    | 11633    | 10005      | 21638      | 35 |
| 26 | 78379    | 89985    | 88393    | 11607    | 10015      | 21621      | 34 |
| 27 | 78395    | 89976    | 88420    | 11580    | 10024      | 21605      | 33 |
| 28 | 78412    | 89966    | 88446    | 11554    | 10034      | 21588      | 32 |
| 29 | 78428    | 89956    | 88472    | 11528    | 10044      | 21572      | 31 |
| 30 | 9.78445  | 9.89947  | 9.88498  | 10.11502 | 10.10053   | 10.21555   | 30 |
| 31 | 78461    | 89937    | 88524    | 11476    | 10063      | 21539      | 29 |
| 32 | 78478    | 89927    | 88550    | 11450    | 10073      | 21522      | 28 |
| 33 | 78494    | 89917    | 88576    | 11424    | 10082      | 21506      | 27 |
| 34 | 78510    | 89908    | 88603    | 11397    | 10092      | 21490      | 26 |
| 35 | 78527    | 89898    | 88629    | 11371    | 10102      | 21473      | 25 |
| 36 | 78543    | 89888    | 88655    | 11345    | 10112      | 21457      | 24 |
| 37 | 78560    | 89879    | 88681    | 11319    | 10121      | 21440      | 23 |
| 38 | 78576    | 89869    | 88707    | 11293    | 10131      | 21424      | 22 |
| 39 | 78592    | 89859    | 88733    | 11267    | 10141      | 21408      | 21 |
| 40 | 9.78609  | 9.89849  | 9.88759  | 10.11241 | 10.10151   | 10.21391   | 20 |
| 41 | 78625    | 89840    | 88786    | 11214    | 10160      | 21375      | 19 |
| 42 | 78642    | 89830    | 88812    | 11188    | 10170      | 21358      | 18 |
| 43 | 78658    | 89820    | 88838    | 11162    | 10180      | 21342      | 17 |
| 44 | 78674    | 89810    | 88864    | 11136    | 10190      | 21326      | 16 |
| 45 | 78691    | 89801    | 88890    | 11110    | 10199      | 21309      | 15 |
| 46 | 78707    | 89791    | 88916    | 11084    | 10209      | 21293      | 14 |
| 47 | 78723    | 89781    | 88942    | 11058    | 10219      | 21277      | 13 |
| 48 | 78739    | 89771    | 88968    | 11032    | 10229      | 21261      | 12 |
| 49 | 78756    | 89761    | 88994    | 11006    | 10239      | 21244      | 11 |
| 50 | 9.78772  | 9.89752  | 9.89020  | 10.10980 | 10.10248   | 10.21228   | 10 |
| 51 | 78788    | 89742    | 89046    | 10954    | 10258      | 21212      | 9  |
| 52 | 78805    | 89732    | 89073    | 10927    | 10268      | 21195      | 8  |
| 53 | 78821    | 89722    | 89099    | 10901    | 10278      | 21179      | 7  |
| 54 | 78837    | 89712    | 89125    | 10875    | 10288      | 21163      | 6  |
| 55 | 78853    | 89702    | 89151    | 10849    | 10298      | 21147      | 5  |
| 56 | 78869    | 89693    | 89177    | 10823    | 10307      | 21131      | 4  |
| 57 | 78886    | 89683    | 89203    | 10797    | 10317      | 21114      | 3  |
| 58 | 78902    | 89673    | 89229    | 10771    | 10327      | 21098      | 2  |
| 59 | 78918    | 89663    | 89255    | 10745    | 10337      | 21082      | 1  |
| 60 | 78934    | 89653    | 89281    | 10719    | 10347      | 21066      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 38 Degrees

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 9.78934  | 9.89653  | 9.89281  | 10.10719 | 10.10347   | 10.21066   | 60 |
| 1  | 78950    | 89643    | 89307    | 10693    | 10357      | 21050      | 59 |
| 2  | 78967    | 89633    | 89333    | 10667    | 10367      | 21033      | 58 |
| 3  | 78983    | 89624    | 89359    | 10641    | 10376      | 21017      | 57 |
| 4  | 78999    | 89614    | 89385    | 10615    | 10386      | 21001      | 56 |
| 5  | 79015    | 89604    | 89411    | 10589    | 10396      | 20985      | 55 |
| 6  | 79031    | 89594    | 89437    | 10563    | 10406      | 20969      | 54 |
| 7  | 79047    | 89584    | 89463    | 10537    | 10416      | 20953      | 53 |
| 8  | 79063    | 89574    | 89489    | 10511    | 10426      | 20937      | 52 |
| 9  | 79079    | 89564    | 89515    | 10485    | 10436      | 20921      | 51 |
| 10 | 9.79095  | 9.89554  | 9.89541  | 10.10459 | 10.10446   | 10.20905   | 50 |
| 11 | 79111    | 89544    | 89567    | 10433    | 10456      | 20889      | 49 |
| 12 | 79128    | 89534    | 89593    | 10407    | 10466      | 20872      | 48 |
| 13 | 79144    | 89524    | 89619    | 10381    | 10476      | 20856      | 47 |
| 14 | 79160    | 89514    | 89645    | 10355    | 10486      | 20840      | 46 |
| 15 | 79176    | 89504    | 89671    | 10329    | 10496      | 20824      | 45 |
| 16 | 79192    | 89495    | 89697    | 10303    | 10505      | 20808      | 44 |
| 17 | 79208    | 89485    | 89723    | 10277    | 10515      | 20792      | 43 |
| 18 | 79224    | 89475    | 89749    | 10251    | 10525      | 20776      | 42 |
| 19 | 79240    | 89465    | 89775    | 10225    | 10535      | 20760      | 41 |
| 20 | 9.79256  | 9.89455  | 9.89801  | 10.10199 | 10.10545   | 10.20744   | 40 |
| 21 | 79272    | 89445    | 89827    | 10173    | 10555      | 20728      | 39 |
| 22 | 79288    | 89435    | 89853    | 10147    | 10565      | 20712      | 38 |
| 23 | 79304    | 89425    | 89879    | 10121    | 10575      | 20696      | 37 |
| 24 | 79319    | 89415    | 89905    | 10095    | 10585      | 20681      | 36 |
| 25 | 79335    | 89405    | 89931    | 10069    | 10595      | 20665      | 35 |
| 26 | 79351    | 89395    | 89957    | 10043    | 10605      | 20649      | 34 |
| 27 | 79367    | 89385    | 89983    | 10017    | 10615      | 20633      | 33 |
| 28 | 79383    | 89375    | 90009    | 99991    | 10625      | 20617      | 32 |
| 29 | 79399    | 89364    | 90035    | 99965    | 10636      | 20601      | 31 |
| 30 | 9.79415  | 9.89354  | 9.90060  | 10.09939 | 10.10646   | 10.20585   | 30 |
| 31 | 79431    | 89344    | 90086    | 99914    | 10656      | 20569      | 29 |
| 32 | 79447    | 89334    | 90112    | 99888    | 10666      | 20553      | 28 |
| 33 | 79463    | 89324    | 90138    | 99862    | 10676      | 20537      | 27 |
| 34 | 79478    | 89314    | 90164    | 99836    | 10686      | 20522      | 26 |
| 35 | 79494    | 89304    | 90190    | 99810    | 10696      | 20506      | 25 |
| 36 | 79510    | 89294    | 90216    | 99784    | 10706      | 20490      | 24 |
| 37 | 79526    | 89284    | 90242    | 99758    | 10716      | 20474      | 23 |
| 38 | 79542    | 89274    | 90268    | 99732    | 10726      | 20458      | 22 |
| 39 | 79558    | 89264    | 90294    | 99706    | 10736      | 20442      | 21 |
| 40 | 9.79573  | 9.89254  | 9.90320  | 10.09680 | 10.10746   | 10.20427   | 20 |
| 41 | 79589    | 89244    | 90346    | 99654    | 10756      | 20411      | 19 |
| 42 | 79605    | 89233    | 90371    | 99629    | 10767      | 20395      | 18 |
| 43 | 79621    | 89223    | 90397    | 99603    | 10777      | 20379      | 17 |
| 44 | 79636    | 89213    | 90423    | 99577    | 10787      | 20364      | 16 |
| 45 | 79652    | 89203    | 90449    | 99551    | 10797      | 20348      | 15 |
| 46 | 79668    | 89193    | 90475    | 99525    | 10807      | 20332      | 14 |
| 47 | 79684    | 89183    | 90501    | 99499    | 10817      | 20316      | 13 |
| 48 | 79699    | 89173    | 90527    | 99473    | 10827      | 20301      | 12 |
| 49 | 79715    | 89162    | 90553    | 99447    | 10838      | 20285      | 11 |
| 50 | 9.79731  | 9.89152  | 9.90578  | 10.09422 | 10.10848   | 10.20269   | 10 |
| 51 | 79746    | 89142    | 90604    | 99396    | 10858      | 20254      | 9  |
| 52 | 79762    | 89132    | 90630    | 99370    | 10868      | 20238      | 8  |
| 53 | 79778    | 89122    | 90656    | 99344    | 10878      | 20222      | 7  |
| 54 | 79793    | 89112    | 90682    | 99318    | 10888      | 20207      | 6  |
| 55 | 79809    | 89101    | 90708    | 99292    | 10899      | 20191      | 5  |
| 56 | 79825    | 89091    | 90734    | 99266    | 10909      | 20175      | 4  |
| 57 | 79840    | 89081    | 90759    | 99241    | 10919      | 20160      | 3  |
| 58 | 79856    | 89071    | 90785    | 99215    | 10929      | 20144      | 2  |
| 59 | 79872    | 89060    | 90811    | 99189    | 10940      | 20128      | 1  |
| 60 | 79887    | 89050    | 90837    | 99163    | 10950      | 20113      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M  |



TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 39 Degrees.

| M. | Sine. | Co-sine. | Tangent. | Co-tang. | Secant.   | Co-secant. |           |
|----|-------|----------|----------|----------|-----------|------------|-----------|
| 60 | 0     | 9. 79887 | 9. 89030 | 9. 90837 | 10. 09163 | 10. 10950  | 10. 20113 |
| 59 | 1     | 79903    | 89040    | 90863    | 09137     | 10960      | 20097     |
| 58 | 2     | 79918    | 89030    | 90889    | 09111     | 10970      | 20082     |
| 57 | 3     | 79934    | 89020    | 90914    | 09086     | 10980      | 20066     |
| 56 | 4     | 79950    | 89009    | 90940    | 09060     | 10991      | 20050     |
| 55 | 5     | 79965    | 88999    | 90966    | 09034     | 11001      | 20035     |
| 54 | 6     | 79982    | 88989    | 90992    | 09008     | 11011      | 20019     |
| 53 | 7     | 79996    | 88978    | 91018    | 08982     | 11022      | 20004     |
| 52 | 8     | 80012    | 88968    | 91043    | 08957     | 11032      | 19988     |
| 51 | 9     | 80027    | 88958    | 91069    | 08931     | 11042      | 19973     |
| 50 | 10    | 9. 80043 | 9. 88948 | 9. 91095 | 10. 08905 | 10. 11052  | 10. 19957 |
| 49 | 11    | 80058    | 88937    | 91121    | 08879     | 11063      | 19942     |
| 48 | 12    | 80074    | 88927    | 91147    | 08853     | 11073      | 19926     |
| 47 | 13    | 80089    | 88917    | 91172    | 08828     | 11083      | 19911     |
| 46 | 14    | 80105    | 88906    | 91198    | 08802     | 11094      | 19895     |
| 45 | 15    | 80120    | 88896    | 91224    | 08776     | 11104      | 19880     |
| 44 | 16    | 80136    | 88886    | 91250    | 08750     | 11114      | 19864     |
| 43 | 17    | 80151    | 88875    | 91276    | 08724     | 11125      | 19849     |
| 42 | 18    | 80166    | 88865    | 91301    | 08699     | 11135      | 19834     |
| 41 | 19    | 80182    | 88855    | 91327    | 08673     | 11145      | 19818     |
| 40 | 20    | 9. 80197 | 9. 88844 | 9. 91353 | 10. 08647 | 10. 11156  | 10. 19803 |
| 39 | 21    | 80213    | 88834    | 91379    | 08621     | 11166      | 19787     |
| 38 | 22    | 80228    | 88824    | 91404    | 08596     | 11176      | 19772     |
| 37 | 23    | 80244    | 88813    | 91430    | 08570     | 11187      | 19756     |
| 36 | 24    | 80259    | 88803    | 91456    | 08544     | 11197      | 19741     |
| 35 | 25    | 80274    | 88793    | 91482    | 08518     | 11207      | 19726     |
| 34 | 26    | 80290    | 88782    | 91507    | 08493     | 11218      | 19710     |
| 33 | 27    | 80305    | 88772    | 91533    | 08467     | 11228      | 19695     |
| 32 | 28    | 80320    | 88761    | 91559    | 08441     | 11239      | 19680     |
| 31 | 29    | 80336    | 88751    | 91585    | 08415     | 11249      | 19664     |
| 30 | 30    | 9. 80351 | 9. 88741 | 9. 91610 | 10. 08390 | 10. 11259  | 10. 19649 |
| 29 | 31    | 80366    | 88730    | 91636    | 08364     | 11270      | 19634     |
| 28 | 32    | 80382    | 88720    | 91662    | 08338     | 11280      | 19618     |
| 27 | 33    | 80397    | 88709    | 91688    | 08312     | 11291      | 19603     |
| 26 | 34    | 80412    | 88699    | 91713    | 08287     | 11301      | 19588     |
| 25 | 35    | 80428    | 88688    | 91739    | 08261     | 11312      | 19572     |
| 24 | 36    | 80443    | 88678    | 91765    | 08235     | 11322      | 19557     |
| 23 | 37    | 80458    | 88668    | 91791    | 08209     | 11332      | 19542     |
| 22 | 38    | 80473    | 88657    | 91816    | 08184     | 11343      | 19527     |
| 21 | 39    | 80489    | 88647    | 91842    | 08158     | 11353      | 19511     |
| 20 | 40    | 9. 80504 | 9. 88636 | 9. 91868 | 10. 08132 | 10. 11364  | 10. 19496 |
| 19 | 41    | 80519    | 88626    | 91893    | 08107     | 11374      | 19482     |
| 18 | 42    | 80534    | 88615    | 91919    | 08081     | 11385      | 19466     |
| 17 | 43    | 80550    | 88605    | 91945    | 08055     | 11395      | 19450     |
| 16 | 44    | 80565    | 88594    | 91971    | 08029     | 11406      | 19435     |
| 15 | 45    | 80580    | 88584    | 91996    | 08004     | 11416      | 19420     |
| 14 | 46    | 80595    | 88573    | 92022    | 07978     | 11427      | 19405     |
| 13 | 47    | 80610    | 88563    | 92048    | 07952     | 11437      | 19390     |
| 12 | 48    | 80625    | 88552    | 92073    | 07927     | 11448      | 19375     |
| 11 | 49    | 80641    | 88542    | 92099    | 07901     | 11458      | 19359     |
| 10 | 50    | 9. 80656 | 9. 88531 | 9. 92125 | 10. 07875 | 10. 11469  | 10. 19344 |
| 9  | 51    | 80671    | 88521    | 92150    | 07850     | 11479      | 19329     |
| 8  | 52    | 80686    | 88510    | 92176    | 07824     | 11490      | 19314     |
| 7  | 53    | 80701    | 88499    | 92202    | 07798     | 11501      | 19299     |
| 6  | 54    | 80716    | 88489    | 92227    | 07773     | 11511      | 19284     |
| 5  | 55    | 80731    | 88478    | 92253    | 07747     | 11522      | 19269     |
| 4  | 56    | 80746    | 88468    | 92279    | 07721     | 11532      | 19254     |
| 3  | 57    | 80762    | 88457    | 92304    | 07696     | 11543      | 19238     |
| 2  | 58    | 80777    | 88447    | 92330    | 07670     | 11553      | 19223     |
| 1  | 59    | 80792    | 88436    | 92356    | 07644     | 11564      | 19208     |
| 0  | 60    | 80807    | 88425    | 92381    | 07619     | 11575      | 19193     |
|    |       | Co-sine. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.   |

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 40 Degrees

| M. | Sine.    | Co-fine. | Tangent. | Co-tang.  | Secant.    | Co-secant. |    |
|----|----------|----------|----------|-----------|------------|------------|----|
| 0  | 9. 80807 | 9. 88425 | 9. 92381 | 10. 07619 | 10. 11575  | 10. 19193  | 60 |
| 1  | 80822    | 88415    | 92407    | 07593     | 11585      | 19178      | 59 |
| 2  | 80837    | 88404    | 92433    | 07567     | 11596      | 19163      | 58 |
| 3  | 80852    | 88394    | 92458    | 07542     | 11606      | 19148      | 57 |
| 4  | 80867    | 88383    | 92484    | 07516     | 11617      | 19133      | 56 |
| 5  | 80882    | 88372    | 92510    | 07490     | 11628      | 19118      | 55 |
| 6  | 80897    | 88362    | 92535    | 07465     | 11638      | 19103      | 54 |
| 7  | 80912    | 88351    | 92561    | 07439     | 11649      | 19088      | 53 |
| 8  | 80927    | 88340    | 92587    | 07413     | 11660      | 19073      | 52 |
| 9  | 80942    | 88330    | 92612    | 07388     | 11670      | 19058      | 51 |
| 10 | 9. 80957 | 9. 88319 | 9. 92638 | 10. 07362 | 10. 11681  | 10. 19043  | 50 |
| 11 | 80972    | 88308    | 92663    | 07337     | 11692      | 19028      | 49 |
| 12 | 80987    | 88298    | 92689    | 07311     | 11702      | 19013      | 48 |
| 13 | 81002    | 88287    | 92715    | 07285     | 11713      | 18998      | 47 |
| 14 | 81017    | 88276    | 92740    | 07260     | 11724      | 18983      | 46 |
| 15 | 81032    | 88266    | 92766    | 07234     | 11734      | 18968      | 45 |
| 16 | 81046    | 88255    | 92792    | 07208     | 11745      | 18954      | 44 |
| 17 | 81061    | 88244    | 92817    | 07183     | 11756      | 18939      | 43 |
| 18 | 81076    | 88234    | 92843    | 07157     | 11766      | 18924      | 42 |
| 19 | 81091    | 88223    | 92868    | 07132     | 11777      | 18909      | 41 |
| 20 | 9. 81106 | 9. 88212 | 9. 92894 | 10. 07106 | 10. 11788  | 10. 18894  | 40 |
| 21 | 81121    | 88201    | 92920    | 07080     | 11799      | 18879      | 39 |
| 22 | 81136    | 88191    | 92945    | 07055     | 11809      | 18864      | 38 |
| 23 | 81151    | 88180    | 92971    | 07029     | 11820      | 18849      | 37 |
| 24 | 81166    | 88169    | 92996    | 07004     | 11831      | 18834      | 36 |
| 25 | 81180    | 88158    | 93022    | 06978     | 11842      | 18820      | 35 |
| 26 | 81195    | 88148    | 93048    | 06952     | 11852      | 18805      | 34 |
| 27 | 81210    | 88137    | 93073    | 06927     | 11863      | 18790      | 33 |
| 28 | 81225    | 88126    | 93099    | 06901     | 11874      | 18775      | 32 |
| 29 | 81240    | 88115    | 93124    | 06876     | 11885      | 18760      | 31 |
| 30 | 9. 81254 | 9. 88105 | 9. 93150 | 10. 06850 | 10. 11895  | 10. 18746  | 30 |
| 31 | 81269    | 88094    | 93175    | 06825     | 11906      | 18731      | 29 |
| 32 | 81284    | 88083    | 93201    | 06799     | 11917      | 18716      | 28 |
| 33 | 81299    | 88072    | 93227    | 06773     | 11928      | 18701      | 27 |
| 34 | 81314    | 88061    | 93252    | 06748     | 11939      | 18686      | 26 |
| 35 | 81328    | 88050    | 93278    | 06722     | 11949      | 18672      | 25 |
| 36 | 81343    | 88040    | 93303    | 06697     | 11960      | 18657      | 24 |
| 37 | 81358    | 88029    | 93329    | 06671     | 11971      | 18642      | 23 |
| 38 | 81372    | 88018    | 93354    | 06646     | 11982      | 18628      | 22 |
| 39 | 81387    | 88007    | 93380    | 06620     | 11993      | 18613      | 21 |
| 40 | 9. 81402 | 9. 87996 | 9. 93406 | 10. 06594 | 10. 12004  | 10. 18598  | 20 |
| 41 | 81417    | 87985    | 93431    | 06569     | 12015      | 18583      | 19 |
| 42 | 81431    | 87975    | 93457    | 06543     | 12025      | 18569      | 18 |
| 43 | 81446    | 87964    | 93482    | 06518     | 12036      | 18554      | 17 |
| 44 | 81461    | 87953    | 93508    | 06492     | 12047      | 18539      | 16 |
| 45 | 81475    | 87942    | 93533    | 06467     | 12058      | 18525      | 15 |
| 46 | 81490    | 87931    | 93559    | 06441     | 12069      | 18510      | 14 |
| 47 | 81505    | 87920    | 93584    | 06416     | 12080      | 18495      | 13 |
| 48 | 81519    | 87909    | 93610    | 06390     | 12091      | 18481      | 12 |
| 49 | 81534    | 87898    | 93635    | 06364     | 12102      | 18466      | 11 |
| 50 | 9. 81549 | 9. 87887 | 9. 93661 | 10. 06339 | 10. 12113  | 10. 18451  | 10 |
| 51 | 81563    | 87877    | 93687    | 06313     | 12123      | 18437      | 9  |
| 52 | 81578    | 87866    | 93712    | 06288     | 12134      | 18422      | 8  |
| 53 | 81592    | 87855    | 93738    | 06262     | 12145      | 18408      | 7  |
| 54 | 81607    | 87844    | 93763    | 06237     | 12156      | 18393      | 6  |
| 55 | 81622    | 87833    | 93789    | 06211     | 12167      | 18378      | 5  |
| 56 | 81636    | 87822    | 93814    | 06186     | 12178      | 18364      | 4  |
| 57 | 81651    | 87811    | 93840    | 06160     | 12189      | 18349      | 3  |
| 58 | 81665    | 87800    | 93865    | 06135     | 12200      | 18335      | 2  |
| 59 | 81680    | 87789    | 93891    | 06109     | 12211      | 18320      | 1  |
| 60 | 81694    | 87778    | 93916    | 06084     | 12222      | 18306      | 0  |
|    | Co-fine. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    | M. |

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 41 Degrees.

|    | M. | Sine.    | Co-sine. | Tangent. | Co-tang.  | Secant.    | Co-secant. |    |
|----|----|----------|----------|----------|-----------|------------|------------|----|
| 60 | 0  | 9. 81694 | 9. 87778 | 9. 93916 | 10. 06084 | 10. 12222  | 10. 18306  | 60 |
| 59 | 1  | 81709    | 87767    | 93912    | 06058     | 12233      | 18291      | 59 |
| 58 | 2  | 81723    | 87756    | 93967    | 06033     | 12244      | 18277      | 58 |
| 57 | 3  | 81738    | 87745    | 93993    | 06007     | 12255      | 18262      | 57 |
| 56 | 4  | 81752    | 87734    | 94018    | 05982     | 12266      | 18248      | 56 |
| 55 | 5  | 81767    | 87723    | 94044    | 05956     | 12277      | 18233      | 55 |
| 54 | 6  | 81781    | 87712    | 94069    | 05931     | 12288      | 18219      | 54 |
| 53 | 7  | 81796    | 87701    | 94095    | 05905     | 12299      | 18204      | 53 |
| 52 | 8  | 81810    | 87690    | 94120    | 05880     | 12310      | 18190      | 52 |
| 51 | 9  | 81825    | 87679    | 94146    | 05854     | 12321      | 18175      | 51 |
| 50 | 10 | 9. 81839 | 9. 87668 | 9. 94171 | 10. 05829 | 10. 12332  | 10. 18161  | 50 |
| 49 | 11 | 81854    | 87657    | 94197    | 05803     | 12343      | 18146      | 49 |
| 48 | 12 | 81868    | 87646    | 94222    | 05778     | 12354      | 18132      | 48 |
| 47 | 13 | 81882    | 87635    | 94248    | 05752     | 12365      | 18118      | 47 |
| 46 | 14 | 81897    | 87624    | 94273    | 05727     | 12376      | 18103      | 46 |
| 45 | 15 | 81911    | 87613    | 94299    | 05701     | 12387      | 18089      | 45 |
| 44 | 16 | 81926    | 87601    | 94324    | 05676     | 12399      | 18074      | 44 |
| 43 | 17 | 81940    | 87590    | 94350    | 05650     | 12410      | 18060      | 43 |
| 42 | 18 | 81954    | 87579    | 94375    | 05625     | 12421      | 18046      | 42 |
| 41 | 19 | 81969    | 87568    | 94401    | 05599     | 12432      | 18031      | 41 |
| 40 | 20 | 9. 81983 | 9. 87557 | 9. 94426 | 10. 05574 | 10. 12443  | 10. 18017  | 40 |
| 39 | 21 | 81998    | 87546    | 94452    | 05548     | 12454      | 18002      | 39 |
| 38 | 22 | 82012    | 87535    | 94477    | 05523     | 12465      | 17988      | 38 |
| 37 | 23 | 82026    | 87524    | 94503    | 05497     | 12476      | 17974      | 37 |
| 36 | 24 | 82041    | 87513    | 94528    | 05472     | 12487      | 17959      | 36 |
| 35 | 25 | 82055    | 87501    | 94554    | 05446     | 12499      | 17945      | 35 |
| 34 | 26 | 82069    | 87490    | 94579    | 05421     | 12510      | 17931      | 34 |
| 33 | 27 | 82084    | 87479    | 94604    | 05396     | 12521      | 17916      | 33 |
| 32 | 28 | 82098    | 87468    | 94630    | 05370     | 12532      | 17902      | 32 |
| 31 | 29 | 82112    | 87457    | 94655    | 05345     | 12543      | 17888      | 31 |
| 30 | 30 | 9. 82126 | 9. 87446 | 9. 94681 | 10. 05319 | 10. 12554  | 10. 17874  | 30 |
| 29 | 31 | 82141    | 87434    | 94706    | 05294     | 12566      | 17859      | 29 |
| 28 | 32 | 82155    | 87423    | 94732    | 05268     | 12577      | 17845      | 28 |
| 27 | 33 | 82169    | 87412    | 94757    | 05243     | 12588      | 17831      | 27 |
| 26 | 34 | 82184    | 87401    | 94783    | 05217     | 12599      | 17816      | 26 |
| 25 | 35 | 82198    | 87390    | 94808    | 05192     | 12610      | 17802      | 25 |
| 24 | 36 | 82212    | 87378    | 94834    | 05166     | 12622      | 17788      | 24 |
| 23 | 37 | 82226    | 87367    | 94859    | 05141     | 12633      | 17774      | 23 |
| 22 | 38 | 82240    | 87356    | 94884    | 05116     | 12644      | 17760      | 22 |
| 21 | 39 | 82255    | 87345    | 94910    | 05090     | 12655      | 17745      | 21 |
| 20 | 40 | 9. 82269 | 9. 87334 | 9. 94935 | 10. 05065 | 10. 12666  | 10. 17731  | 20 |
| 19 | 41 | 82283    | 87322    | 94961    | 05039     | 12678      | 17717      | 19 |
| 18 | 42 | 82297    | 87311    | 94986    | 05014     | 12689      | 17703      | 18 |
| 17 | 43 | 82311    | 87300    | 95012    | 04988     | 12700      | 17689      | 17 |
| 16 | 44 | 82326    | 87288    | 95037    | 04963     | 12711      | 17674      | 16 |
| 15 | 45 | 82340    | 87277    | 95062    | 04938     | 12723      | 17660      | 15 |
| 14 | 46 | 82354    | 87266    | 95088    | 04912     | 12734      | 17646      | 14 |
| 13 | 47 | 82368    | 87255    | 95113    | 04887     | 12745      | 17632      | 13 |
| 12 | 48 | 82382    | 87243    | 95139    | 04861     | 12757      | 17618      | 12 |
| 11 | 49 | 82396    | 87232    | 95164    | 04836     | 12768      | 17604      | 11 |
| 10 | 50 | 9. 82410 | 9. 87221 | 9. 95190 | 10. 04810 | 10. 12779  | 10. 17590  | 10 |
| 9  | 51 | 82424    | 87209    | 95215    | 04785     | 12791      | 17576      | 9  |
| 8  | 52 | 82439    | 87198    | 95240    | 04760     | 12802      | 17561      | 8  |
| 7  | 53 | 82453    | 87187    | 95266    | 04734     | 12813      | 17547      | 7  |
| 6  | 54 | 82467    | 87175    | 95291    | 04709     | 12825      | 17533      | 6  |
| 5  | 55 | 82481    | 87164    | 95317    | 04683     | 12836      | 17519      | 5  |
| 4  | 56 | 82495    | 87153    | 95342    | 04658     | 12847      | 17505      | 4  |
| 3  | 57 | 82509    | 87141    | 95368    | 04632     | 12859      | 17491      | 3  |
| 2  | 58 | 82523    | 87130    | 95393    | 04607     | 12870      | 17477      | 2  |
| 1  | 59 | 82537    | 87119    | 95418    | 04582     | 12881      | 17463      | 1  |
| 0  | 60 | 82551    | 87107    | 95444    | 04556     | 12893      | 17449      | 0  |
| M  |    | Co-sine. | Sine.    | Co-tang. | Tangent.  | Co-secant. | Secant.    | M. |

48 Degrees



TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 42 Degree

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 9.82551  | 9.87107  | 9.95444  | 10.04556 | 10.12893   | 10.17449   | 60 |
| 1  | 82565    | 87096    | 95469    | 04531    | 12904      | 17435      | 59 |
| 2  | 82579    | 87083    | 95495    | 04505    | 12915      | 17421      | 58 |
| 3  | 82593    | 87073    | 95520    | 04480    | 12927      | 17407      | 57 |
| 4  | 82607    | 87062    | 95545    | 04455    | 12938      | 17393      | 56 |
| 5  | 82621    | 87050    | 95571    | 04429    | 12950      | 17379      | 55 |
| 6  | 82635    | 87039    | 95596    | 04404    | 12961      | 17365      | 54 |
| 7  | 82649    | 87028    | 95621    | 04378    | 12972      | 17351      | 53 |
| 8  | 82663    | 87016    | 95647    | 04353    | 12984      | 17337      | 52 |
| 9  | 82677    | 87005    | 95672    | 04328    | 12995      | 17323      | 51 |
| 10 | 9.82691  | 9.86993  | 9.95698  | 10.04302 | 10.13007   | 10.17309   | 50 |
| 11 | 82705    | 86982    | 95723    | 04277    | 13018      | 17295      | 49 |
| 12 | 82719    | 86970    | 95748    | 04252    | 13030      | 17281      | 48 |
| 13 | 82733    | 86959    | 95774    | 04226    | 13041      | 17267      | 47 |
| 14 | 82747    | 86947    | 95799    | 04201    | 13053      | 17253      | 46 |
| 15 | 82761    | 86936    | 95825    | 04175    | 13064      | 17239      | 45 |
| 16 | 82775    | 86924    | 95850    | 04150    | 13076      | 17226      | 44 |
| 17 | 82788    | 86913    | 95875    | 04125    | 13087      | 17212      | 43 |
| 18 | 82802    | 86902    | 95901    | 04099    | 13098      | 17198      | 42 |
| 19 | 82816    | 86890    | 95926    | 04074    | 13110      | 17184      | 41 |
| 20 | 9.82830  | 9.86879  | 9.95952  | 10.04048 | 10.13121   | 10.17170   | 40 |
| 21 | 82844    | 86867    | 95977    | 04023    | 13133      | 17156      | 39 |
| 22 | 82858    | 86855    | 96002    | 03998    | 13145      | 17142      | 38 |
| 23 | 82872    | 86844    | 96028    | 03972    | 13156      | 17128      | 37 |
| 24 | 82885    | 86832    | 96053    | 03947    | 13168      | 17115      | 36 |
| 25 | 82899    | 86821    | 96078    | 03922    | 13179      | 17101      | 35 |
| 26 | 82913    | 86809    | 96104    | 03896    | 13191      | 17087      | 34 |
| 27 | 82927    | 86798    | 96129    | 03871    | 13202      | 17073      | 33 |
| 28 | 82941    | 86786    | 96155    | 03845    | 13214      | 17059      | 32 |
| 29 | 82955    | 86775    | 96180    | 03820    | 13225      | 17045      | 31 |
| 30 | 9.82968  | 9.86763  | 9.96205  | 10.03795 | 10.13237   | 10.17032   | 30 |
| 31 | 82982    | 86752    | 96231    | 03769    | 13248      | 17018      | 29 |
| 32 | 82996    | 86740    | 96256    | 03744    | 13260      | 17004      | 28 |
| 33 | 83010    | 86728    | 96281    | 03719    | 13272      | 16990      | 27 |
| 34 | 83023    | 86717    | 96307    | 03693    | 13283      | 16977      | 26 |
| 35 | 83037    | 86705    | 96332    | 03668    | 13295      | 16963      | 25 |
| 36 | 83051    | 86694    | 96357    | 03643    | 13306      | 16949      | 24 |
| 37 | 83065    | 86682    | 96383    | 03617    | 13318      | 16935      | 23 |
| 38 | 83078    | 86670    | 96408    | 03592    | 13330      | 16922      | 22 |
| 39 | 83092    | 86659    | 96433    | 03567    | 13341      | 16908      | 21 |
| 40 | 9.83106  | 9.86647  | 9.96459  | 10.03541 | 10.13353   | 10.16894   | 20 |
| 41 | 83119    | 86635    | 96484    | 03516    | 13365      | 16880      | 19 |
| 42 | 83133    | 86624    | 96510    | 03490    | 13376      | 16867      | 18 |
| 43 | 83147    | 86612    | 96535    | 03465    | 13388      | 16853      | 17 |
| 44 | 83161    | 86600    | 96560    | 03440    | 13400      | 16839      | 16 |
| 45 | 83174    | 86589    | 96586    | 03414    | 13411      | 16826      | 15 |
| 46 | 83188    | 86577    | 96611    | 03389    | 13423      | 16812      | 14 |
| 47 | 83202    | 86565    | 96636    | 03364    | 13435      | 16798      | 13 |
| 48 | 83215    | 86554    | 96662    | 03338    | 13446      | 16785      | 12 |
| 49 | 83229    | 86542    | 96687    | 03313    | 13458      | 16771      | 11 |
| 50 | 9.83242  | 9.86530  | 9.96712  | 10.03288 | 10.13470   | 10.16758   | 10 |
| 51 | 83256    | 86518    | 96738    | 03262    | 13482      | 16744      | 9  |
| 52 | 83270    | 86507    | 96763    | 03237    | 13493      | 16730      | 8  |
| 53 | 83283    | 86495    | 96788    | 03212    | 13505      | 16717      | 7  |
| 54 | 83297    | 86483    | 96814    | 03186    | 13517      | 16703      | 6  |
| 55 | 83310    | 86472    | 96839    | 03161    | 13528      | 16690      | 5  |
| 56 | 83324    | 86460    | 96864    | 03136    | 13540      | 16676      | 4  |
| 57 | 83338    | 86448    | 96890    | 03110    | 13552      | 16662      | 3  |
| 58 | 83351    | 86436    | 96915    | 03085    | 13564      | 16649      | 2  |
| 59 | 83365    | 86425    | 96940    | 03060    | 13575      | 16635      | 1  |
| 60 | 83378    | 86413    | 96966    | 03034    | 13587      | 16622      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |

47 Degrees.

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants. 43 Degrees.

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 9.83378  | 9.86413  | 9.96966  | 10.03034 | 10.13587   | 10.16622   | 60 |
| 1  | 83392    | 86401    | 96991    | 03009    | 13599      | 16608      | 59 |
| 2  | 83405    | 86389    | 97016    | 02984    | 13611      | 16595      | 58 |
| 3  | 83419    | 86377    | 97042    | 02958    | 13623      | 16581      | 57 |
| 4  | 83432    | 86366    | 97067    | 02933    | 13634      | 16568      | 56 |
| 5  | 83446    | 86354    | 97092    | 02908    | 13646      | 16554      | 55 |
| 6  | 83459    | 86342    | 97118    | 02882    | 13658      | 16541      | 54 |
| 7  | 83473    | 86330    | 97143    | 02857    | 13670      | 16527      | 53 |
| 8  | 83486    | 86318    | 97168    | 02832    | 13682      | 16513      | 52 |
| 9  | 83500    | 86306    | 97193    | 02807    | 13694      | 16500      | 51 |
| 10 | 9.83513  | 9.86295  | 9.97219  | 10.02781 | 10.13705   | 10.16487   | 50 |
| 11 | 83527    | 86283    | 97244    | 02756    | 13717      | 16473      | 49 |
| 12 | 83540    | 86271    | 97269    | 02731    | 13729      | 16460      | 48 |
| 13 | 83554    | 86259    | 97294    | 02705    | 13741      | 16446      | 47 |
| 14 | 83567    | 86247    | 97320    | 02680    | 13753      | 16433      | 46 |
| 15 | 83581    | 86235    | 97345    | 02655    | 13765      | 16419      | 45 |
| 16 | 83594    | 86223    | 97371    | 02629    | 13777      | 16406      | 44 |
| 17 | 83607    | 86211    | 97396    | 02604    | 13789      | 16392      | 43 |
| 18 | 83621    | 86200    | 97421    | 02579    | 13800      | 16379      | 42 |
| 19 | 83634    | 86188    | 97447    | 02553    | 13812      | 16366      | 41 |
| 20 | 9.83648  | 9.86176  | 9.97472  | 10.02528 | 10.13824   | 10.16352   | 40 |
| 21 | 83661    | 86164    | 97497    | 02503    | 13836      | 16339      | 39 |
| 22 | 83674    | 86152    | 97523    | 02477    | 13848      | 16326      | 38 |
| 23 | 83688    | 86140    | 97548    | 02452    | 13860      | 16312      | 37 |
| 24 | 83701    | 86128    | 97573    | 02427    | 13872      | 16299      | 36 |
| 25 | 83715    | 86116    | 97598    | 02402    | 13884      | 16285      | 35 |
| 26 | 83728    | 86104    | 97624    | 02376    | 13896      | 16272      | 34 |
| 27 | 83741    | 86092    | 97649    | 02351    | 13908      | 16259      | 33 |
| 28 | 83755    | 86080    | 97674    | 02326    | 13920      | 16245      | 32 |
| 29 | 83768    | 86068    | 97700    | 02300    | 13932      | 16232      | 31 |
| 30 | 9.83781  | 9.86056  | 9.97725  | 10.02275 | 10.13944   | 10.16219   | 30 |
| 31 | 83795    | 86044    | 97750    | 02250    | 13956      | 16205      | 29 |
| 32 | 83808    | 86032    | 97776    | 02224    | 13968      | 16192      | 28 |
| 33 | 83821    | 86020    | 97801    | 02199    | 13980      | 16179      | 27 |
| 34 | 83834    | 86008    | 97826    | 02174    | 13992      | 16166      | 26 |
| 35 | 83848    | 85996    | 97851    | 02149    | 14004      | 16152      | 25 |
| 36 | 83861    | 85984    | 97877    | 02123    | 14016      | 16139      | 24 |
| 37 | 83874    | 85972    | 97902    | 02098    | 14028      | 16126      | 23 |
| 38 | 83887    | 85960    | 97927    | 02073    | 14040      | 16113      | 22 |
| 39 | 83901    | 85948    | 97953    | 02047    | 14052      | 16099      | 21 |
| 40 | 9.83914  | 9.85936  | 9.97978  | 10.02022 | 10.14064   | 10.16086   | 20 |
| 41 | 83927    | 85924    | 98003    | 01997    | 14076      | 16073      | 19 |
| 42 | 83940    | 85912    | 98029    | 01971    | 14088      | 16060      | 18 |
| 43 | 83954    | 85900    | 98054    | 01946    | 14100      | 16046      | 17 |
| 44 | 83967    | 85888    | 98079    | 01921    | 14112      | 16033      | 16 |
| 45 | 83980    | 85876    | 98104    | 01896    | 14124      | 16020      | 15 |
| 46 | 83993    | 85864    | 98130    | 01870    | 14136      | 16007      | 14 |
| 47 | 84006    | 85851    | 98155    | 01845    | 14149      | 15994      | 13 |
| 48 | 84020    | 85839    | 98180    | 01820    | 14161      | 15980      | 12 |
| 49 | 84033    | 85827    | 98206    | 01794    | 14173      | 15967      | 11 |
| 50 | 9.84046  | 9.85815  | 9.98231  | 10.01769 | 10.14185   | 10.15954   | 10 |
| 51 | 84059    | 85803    | 98256    | 01744    | 14197      | 15941      | 9  |
| 52 | 84072    | 85791    | 98281    | 01719    | 14209      | 15928      | 8  |
| 53 | 84085    | 85779    | 98307    | 01693    | 14221      | 15915      | 7  |
| 54 | 84098    | 85766    | 98332    | 01668    | 14234      | 15902      | 6  |
| 55 | 84112    | 85754    | 98357    | 01643    | 14246      | 15888      | 5  |
| 56 | 84125    | 85742    | 98383    | 01617    | 14258      | 15875      | 4  |
| 57 | 84138    | 85730    | 98408    | 01592    | 14270      | 15862      | 3  |
| 58 | 84151    | 85718    | 98433    | 01567    | 14282      | 15849      | 2  |
| 59 | 84164    | 85706    | 98458    | 01542    | 14294      | 15836      | 1  |
| 60 | 84177    | 85693    | 98484    | 01516    | 14307      | 15823      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |

TABLE V. OF ARTIFICIAL Sines, Tangents, and Secants. 44 Degree

| M. | Sine.    | Co-sine. | Tangent. | Co-tang. | Secant.    | Co-secant. |    |
|----|----------|----------|----------|----------|------------|------------|----|
| 0  | 9.84177  | 9.85693  | 9.98484  | 10.01516 | 10.14307   | 10.15823   | 60 |
| 1  | 84190    | 85681    | 98509    | 01491    | 14319      | 15810      | 59 |
| 2  | 84203    | 85669    | 98534    | 01466    | 14331      | 15797      | 58 |
| 3  | 84216    | 85657    | 98560    | 01440    | 14343      | 15784      | 57 |
| 4  | 84229    | 85645    | 98585    | 01415    | 14355      | 15771      | 56 |
| 5  | 84242    | 85632    | 98610    | 01390    | 14368      | 15758      | 55 |
| 6  | 84255    | 85620    | 98635    | 01365    | 14380      | 15745      | 54 |
| 7  | 84269    | 85608    | 98661    | 01339    | 14392      | 15731      | 53 |
| 8  | 84282    | 85596    | 98686    | 01314    | 14404      | 15718      | 52 |
| 9  | 84295    | 85583    | 98711    | 01289    | 14417      | 15705      | 51 |
| 10 | 9.84308  | 9.85571  | 9.98737  | 10.01263 | 10.14429   | 10.15692   | 50 |
| 11 | 84321    | 85559    | 98762    | 01238    | 14441      | 15679      | 49 |
| 12 | 84334    | 85546    | 98787    | 01213    | 14454      | 15666      | 48 |
| 13 | 84347    | 85534    | 98812    | 01188    | 14466      | 15653      | 47 |
| 14 | 84360    | 85522    | 98838    | 01162    | 14478      | 15640      | 46 |
| 15 | 84372    | 85510    | 98863    | 01137    | 14490      | 15627      | 45 |
| 16 | 84385    | 85497    | 98888    | 01112    | 14503      | 15614      | 44 |
| 17 | 84398    | 85485    | 98913    | 01087    | 14515      | 15602      | 43 |
| 18 | 84411    | 85473    | 98939    | 01061    | 14527      | 15589      | 42 |
| 19 | 84424    | 85460    | 98964    | 01036    | 14540      | 15576      | 41 |
| 20 | 9.84437  | 9.85448  | 9.98989  | 10.01011 | 10.14552   | 10.15563   | 40 |
| 21 | 84450    | 85436    | 99014    | 00985    | 14564      | 15550      | 39 |
| 22 | 84463    | 85423    | 99040    | 00960    | 14577      | 15537      | 38 |
| 23 | 84476    | 85411    | 99065    | 00935    | 14589      | 15524      | 37 |
| 24 | 84489    | 85399    | 99090    | 00910    | 14601      | 15511      | 36 |
| 25 | 84502    | 85386    | 99116    | 00884    | 14614      | 15498      | 35 |
| 26 | 84515    | 85374    | 99141    | 00859    | 14626      | 15485      | 34 |
| 27 | 84528    | 85361    | 99166    | 00834    | 14639      | 15472      | 33 |
| 28 | 84540    | 85349    | 99191    | 00809    | 14651      | 15460      | 32 |
| 29 | 84553    | 85337    | 99217    | 00783    | 14663      | 15447      | 31 |
| 30 | 9.84566  | 9.85324  | 9.99242  | 10.00758 | 10.14676   | 10.15434   | 30 |
| 31 | 84579    | 85312    | 99267    | 00733    | 14688      | 15421      | 29 |
| 32 | 84592    | 85299    | 99293    | 00707    | 14701      | 15408      | 28 |
| 33 | 84605    | 85287    | 99318    | 00682    | 14713      | 15395      | 27 |
| 34 | 84618    | 85274    | 99343    | 00657    | 14726      | 15382      | 26 |
| 35 | 84630    | 85262    | 99368    | 00632    | 14738      | 15370      | 25 |
| 36 | 84643    | 85250    | 99394    | 00606    | 14750      | 15357      | 24 |
| 37 | 84656    | 85237    | 99419    | 00581    | 14763      | 15344      | 23 |
| 38 | 84669    | 85225    | 99444    | 00556    | 14775      | 15331      | 22 |
| 39 | 84682    | 85212    | 99469    | 00531    | 14788      | 15318      | 21 |
| 40 | 9.84694  | 9.85200  | 9.99495  | 10.00505 | 10.14800   | 10.15306   | 20 |
| 41 | 84707    | 85187    | 99520    | 00480    | 14813      | 15293      | 19 |
| 42 | 84720    | 85175    | 99545    | 00455    | 14825      | 15280      | 18 |
| 43 | 84733    | 85162    | 99570    | 00430    | 14838      | 15267      | 17 |
| 44 | 84745    | 85150    | 99596    | 00404    | 14850      | 15255      | 16 |
| 45 | 84758    | 85137    | 99621    | 00379    | 14863      | 15242      | 15 |
| 46 | 84771    | 85125    | 99646    | 00354    | 14875      | 15229      | 14 |
| 47 | 84784    | 85112    | 99672    | 00328    | 14888      | 15216      | 13 |
| 48 | 84796    | 85100    | 99697    | 00303    | 14900      | 15204      | 12 |
| 49 | 84809    | 85087    | 99722    | 00278    | 14913      | 15191      | 11 |
| 50 | 9.84822  | 9.85074  | 9.99747  | 10.00253 | 10.14926   | 10.15178   | 10 |
| 51 | 84834    | 85062    | 99773    | 00227    | 14938      | 15166      | 9  |
| 52 | 84847    | 85049    | 99798    | 00202    | 14951      | 15153      | 8  |
| 53 | 84860    | 85037    | 99823    | 00177    | 14963      | 15140      | 7  |
| 54 | 84873    | 85024    | 99848    | 00152    | 14976      | 15127      | 6  |
| 55 | 84885    | 85012    | 99874    | 00126    | 14988      | 15115      | 5  |
| 56 | 84898    | 84999    | 99899    | 00101    | 15001      | 15102      | 4  |
| 57 | 84911    | 84986    | 99924    | 00076    | 15014      | 15089      | 3  |
| 58 | 84923    | 84974    | 99949    | 00051    | 15026      | 15077      | 2  |
| 59 | 84936    | 84961    | 99975    | 00025    | 15039      | 15064      | 1  |
| 60 | 84948    | 84948    | 10.00000 | 10.00000 | 15052      | 15051      | 0  |
|    | Co-sine. | Sine.    | Co-tang. | Tangent. | Co-secant. | Secant.    | M. |

45 Degrees.



TABLE VI. For finding the Latitude, by Two Altitudes of the Sun.

A TABLE for finding the  $\circ$  HOUR.

| M. | S. | Co. ar.      |              |         | M. | S. | Co. ar.      |              |         |
|----|----|--------------|--------------|---------|----|----|--------------|--------------|---------|
|    |    | Elapf. Time. | Middle Time. | Rising. |    |    | Elapf. Time. | Middle Time. | Rising. |
| 59 | 0  | 2.66121      | 2.63982      | 9.37654 | 30 | 30 | 0.87717      | 4.42386      | 2.94656 |
| 58 | 1  | 2.36018      | 2.94085      | 97860   | 31 | 00 | 87015        | 43088        | 96067   |
| 57 | 1  | 2.18409      | 3.11694      | 0.33078 | 31 | 30 | 86324        | 43779        | 97454   |
| 56 | 2  | 2.05916      | 24187        | 58066   | 32 | 00 | 85644        | 44459        | 98820   |
| 55 | 2  | 1.96225      | 33878        | 77448   | 32 | 30 | 84976        | 45127        | 3.00164 |
| 54 | 3  | 88307        | 41796        | 93284   | 33 | 00 | 84317        | 45786        | 01488   |
| 53 | 3  | 81613        | 48490        | 1.06673 | 33 | 30 | 83669        | 46434        | 02792   |
| 52 | 4  | 75814        | 54289        | 18271   | 34 | 00 | 83030        | 47073        | 04077   |
| 51 | 4  | 70700        | 59403        | 28502   | 34 | 30 | 82401        | 47702        | 05342   |
| 50 | 5  | 66125        | 63978        | 37653   | 35 | 00 | 81780        | 48323        | 06590   |
| 49 | 5  | 1.61986      | 3.68117      | 1.45931 | 35 | 30 | 0.81169      | 4.48934      | 3.07819 |
| 48 | 6  | 58208        | 71895        | 53488   | 36 | 00 | 80567        | 49536        | 09032   |
| 47 | 6  | 54733        | 75370        | 60440   | 36 | 30 | 79973        | 50130        | 10227   |
| 46 | 7  | 51515        | 78588        | 66877   | 37 | 00 | 79387        | 50716        | 11406   |
| 45 | 7  | 48520        | 81583        | 72869   | 37 | 30 | 78809        | 51294        | 12570   |
| 44 | 8  | 45718        | 84385        | 78474   | 38 | 00 | 78239        | 51864        | 13718   |
| 43 | 8  | 43086        | 87017        | 83739   | 38 | 30 | 77677        | 52426        | 14850   |
| 42 | 9  | 40605        | 89498        | 88703   | 39 | 00 | 77122        | 52981        | 15969   |
| 41 | 9  | 38258        | 91845        | 93399   | 39 | 30 | 76574        | 53529        | 17072   |
| 40 | 10 | 36032        | 94071        | 97854   | 40 | 00 | 76033        | 54070        | 18162   |
| 39 | 10 | 1.33915      | 3.96188      | 2.02091 | 40 | 30 | 0.75499      | 4.54604      | 3.19238 |
| 38 | 11 | 31896        | 98207        | 06131   | 41 | 00 | 74972        | 55131        | 20301   |
| 37 | 11 | 29967        | 4.00136      | 09991   | 41 | 30 | 74451        | 55652        | 21351   |
| 36 | 12 | 28120        | 01983        | 13687   | 42 | 00 | 73937        | 56166        | 22389   |
| 35 | 12 | 26349        | 03754        | 17223   | 42 | 30 | 73429        | 56674        | 23414   |
| 34 | 13 | 24647        | 05456        | 20638   | 43 | 00 | 72926        | 57176        | 24427   |
| 33 | 13 | 23010        | 07093        | 23915   | 43 | 30 | 72430        | 57673        | 25428   |
| 32 | 14 | 21432        | 08671        | 27073   | 44 | 00 | 71940        | 58163        | 26418   |
| 31 | 14 | 19910        | 10193        | 30120   | 44 | 30 | 71455        | 58648        | 27396   |
| 30 | 15 | 18440        | 11663        | 33063   | 45 | 00 | 70976        | 59127        | 28363   |
| 29 | 15 | 1.17018      | 4.13085      | 2.35910 | 45 | 30 | 0.70503      | 4.59600      | 3.29320 |
| 28 | 16 | 15642        | 14461        | 38667   | 46 | 00 | 70034        | 60069        | 30266   |
| 27 | 16 | 14307        | 15796        | 41338   | 46 | 30 | 69571        | 60532        | 31202   |
| 26 | 17 | 13013        | 17090        | 43930   | 47 | 00 | 69113        | 60990        | 32128   |
| 25 | 17 | 11757        | 18346        | 46447   | 47 | 30 | 68660        | 61443        | 33044   |
| 24 | 18 | 10536        | 19567        | 48893   | 48 | 00 | 68212        | 61891        | 33950   |
| 23 | 18 | 09348        | 20755        | 51271   | 48 | 30 | 67769        | 62334        | 34847   |
| 22 | 19 | 08193        | 21910        | 53586   | 49 | 00 | 67330        | 62773        | 35734   |
| 21 | 19 | 07067        | 23036        | 55841   | 49 | 30 | 66896        | 63207        | 36613   |
| 20 | 20 | 05970        | 24133        | 58039   | 50 | 00 | 66406        | 63637        | 37482   |
| 19 | 20 | 1.04901      | 4.25202      | 2.60182 | 50 | 30 | 0.66041      | 4.64062      | 2.38343 |
| 18 | 21 | 03857        | 26246        | 62274   | 51 | 00 | 65620        | 64483        | 39195   |
| 17 | 21 | 02838        | 27265        | 64316   | 51 | 30 | 65204        | 64899        | 40039   |
| 16 | 22 | 01843        | 28260        | 66312   | 52 | 00 | 64791        | 65312        | 40875   |
| 15 | 22 | 00870        | 29233        | 68262   | 52 | 30 | 64383        | 65720        | 41702   |
| 14 | 23 | 0.99918      | 30185        | 70170   | 53 | 00 | 63978        | 66125        | 42523   |
| 13 | 23 | 98088        | 31115        | 72036   | 53 | 30 | 63578        | 66525        | 43334   |
| 12 | 24 | 98077        | 32026        | 73863   | 54 | 00 | 63181        | 66922        | 44138   |
| 11 | 24 | 97184        | 32919        | 75652   | 54 | 30 | 62789        | 67314        | 44935   |
| 10 | 25 | 96310        | 33793        | 77405   | 55 | 00 | 62400        | 67703        | 45724   |
| 9  | 25 | 0.95454      | 4.34649      | 2.79124 | 55 | 30 | 0.62014      | 4.68089      | 3.46507 |
| 8  | 26 | 94614        | 35489        | 80809   | 56 | 00 | 61632        | 68471        | 47282   |
| 7  | 26 | 93791        | 36313        | 82461   | 56 | 30 | 61254        | 68849        | 48050   |
| 6  | 27 | 92982        | 37121        | 84083   | 57 | 00 | 60879        | 69224        | 48811   |
| 5  | 27 | 92189        | 37914        | 85675   | 57 | 30 | 60508        | 69595        | 49566   |
| 4  | 28 | 91411        | 38692        | 87238   | 58 | 00 | 60140        | 69963        | 50314   |
| 3  | 28 | 90646        | 39457        | 88773   | 58 | 30 | 59775        | 70328        | 51056   |
| 2  | 29 | 89894        | 40209        | 90282   | 59 | 00 | 59414        | 70689        | 51791   |
| 1  | 29 | 89156        | 40947        | 91765   | 59 | 30 | 59056        | 71047        | 52520   |
| 0  | 30 | 88430        | 41673        | 93223   | 60 | 00 | 58700        | 71403        | 53243   |

TABLE VI. For finding the Latitude, by Two Altitudes of the Sun.

## LATITUDE by two Altitudes. 1 HOUR.

| M. | S. | $\frac{1}{2}$ Elapf. Time. | Middle Time. | Rising. | M. | S. | $\frac{1}{2}$ Elapf. Time. | Middle Time. | Rising. |
|----|----|----------------------------|--------------|---------|----|----|----------------------------|--------------|---------|
| 00 | 30 | 0.58348                    | 4.71755      | 3.53959 | 30 | 30 | 0.41488                    | 4.88615      | 3.88625 |
| 01 | 00 | 57999                      | 72104        | 54670   | 31 | 00 | 41261                      | 88842        | 89097   |
| 01 | 30 | 57653                      | 72450        | 55375   | 31 | 30 | 41036                      | 89067        | 89567   |
| 02 | 00 | 57310                      | 72793        | 56074   | 32 | 00 | 40812                      | 89291        | 90034   |
| 02 | 30 | 56970                      | 73133        | 56767   | 32 | 30 | 40590                      | 89513        | 90498   |
| 03 | 00 | 56633                      | 73470        | 57455   | 33 | 00 | 40368                      | 89734        | 90960   |
| 03 | 30 | 56298                      | 73805        | 58137   | 33 | 30 | 40149                      | 89954        | 91420   |
| 04 | 00 | 55966                      | 74137        | 58814   | 34 | 00 | 39930                      | 90173        | 91876   |
| 04 | 30 | 55637                      | 74466        | 59486   | 34 | 30 | 39713                      | 90390        | 92331   |
| 05 | 00 | 55311                      | 74792        | 60152   | 35 | 00 | 39497                      | 90606        | 92782   |
| 05 | 30 | 0.54987                    | 4.75116      | 3.60813 | 35 | 30 | 0.39282                    | 4.90821      | 3.93232 |
| 06 | 00 | 54666                      | 75437        | 61469   | 36 | 00 | 39069                      | 91034        | 93679   |
| 06 | 30 | 54347                      | 75756        | 62120   | 36 | 30 | 38856                      | 91247        | 94122   |
| 07 | 00 | 54031                      | 76072        | 62766   | 37 | 00 | 38646                      | 91457        | 94566   |
| 07 | 30 | 53718                      | 76385        | 63407   | 37 | 30 | 38436                      | 91667        | 95000   |
| 08 | 00 | 53406                      | 76697        | 64043   | 38 | 00 | 38227                      | 91876        | 95441   |
| 08 | 30 | 53097                      | 77005        | 64675   | 38 | 30 | 38020                      | 92083        | 95877   |
| 09 | 00 | 52791                      | 77312        | 65302   | 39 | 00 | 37814                      | 92289        | 96311   |
| 09 | 30 | 52487                      | 77616        | 65924   | 39 | 30 | 37609                      | 92494        | 96742   |
| 10 | 00 | 52186                      | 77917        | 66542   | 40 | 00 | 37405                      | 92698        | 97170   |
| 10 | 30 | 0.51886                    | 4.78217      | 3.67156 | 40 | 30 | 0.37203                    | 4.92900      | 3.97597 |
| 11 | 00 | 51589                      | 78514        | 67765   | 41 | 00 | 37001                      | 93102        | 98021   |
| 11 | 30 | 51294                      | 78809        | 68369   | 41 | 30 | 36801                      | 93301        | 98444   |
| 12 | 00 | 51002                      | 79101        | 68969   | 42 | 00 | 36602                      | 93501        | 98866   |
| 12 | 30 | 50711                      | 79392        | 69566   | 42 | 30 | 36403                      | 93700        | 99286   |
| 13 | 00 | 50423                      | 79680        | 70158   | 43 | 00 | 36206                      | 93897        | 99699   |
| 13 | 30 | 50137                      | 79966        | 70745   | 43 | 30 | 36011                      | 94097        | 4.00106 |
| 14 | 00 | 49852                      | 80251        | 71329   | 44 | 00 | 35816                      | 94287        | 00521   |
| 14 | 30 | 49570                      | 80533        | 71909   | 44 | 30 | 35622                      | 94481        | 00933   |
| 15 | 00 | 49290                      | 80813        | 72485   | 45 | 00 | 35429                      | 94673        | 01331   |
| 15 | 30 | 0.49012                    | 4.81091      | 3.73057 | 45 | 30 | 0.35238                    | 4.94865      | 4.01742 |
| 16 | 00 | 48736                      | 81367        | 73625   | 46 | 00 | 35047                      | 95036        | 02146   |
| 16 | 30 | 48462                      | 81641        | 74189   | 46 | 30 | 34858                      | 95243        | 02547   |
| 17 | 00 | 48189                      | 81914        | 74750   | 47 | 00 | 34669                      | 95434        | 02947   |
| 17 | 30 | 47919                      | 82184        | 75307   | 47 | 30 | 34482                      | 95621        | 03344   |
| 18 | 00 | 47650                      | 82453        | 75860   | 48 | 00 | 34295                      | 95808        | 03747   |
| 18 | 30 | 47384                      | 82719        | 76409   | 48 | 30 | 34110                      | 95993        | 04133   |
| 19 | 00 | 47119                      | 82984        | 76955   | 49 | 00 | 33925                      | 96178        | 04522   |
| 19 | 30 | 46856                      | 83247        | 77498   | 49 | 30 | 33742                      | 96361        | 04910   |
| 20 | 00 | 46595                      | 83508        | 78037   | 50 | 00 | 33559                      | 96544        | 05300   |
| 20 | 30 | 0.46335                    | 4.83768      | 3.78573 | 50 | 30 | 0.33378                    | 4.96725      | 4.05699 |
| 21 | 00 | 46078                      | 84025        | 79105   | 51 | 00 | 33197                      | 96906        | 06077   |
| 21 | 30 | 45822                      | 84281        | 79634   | 51 | 30 | 33018                      | 97085        | 06453   |
| 22 | 00 | 45567                      | 84536        | 80159   | 52 | 00 | 32839                      | 97264        | 06833   |
| 22 | 30 | 45315                      | 84788        | 80682   | 52 | 30 | 32661                      | 97442        | 07211   |
| 23 | 00 | 45064                      | 85039        | 81201   | 53 | 00 | 32485                      | 97618        | 07599   |
| 23 | 30 | 44815                      | 85288        | 81717   | 53 | 30 | 32309                      | 97794        | 07977   |
| 24 | 00 | 44567                      | 85536        | 82230   | 54 | 00 | 32134                      | 97969        | 08344   |
| 24 | 30 | 44321                      | 85782        | 82739   | 54 | 30 | 31960                      | 98143        | 08711   |
| 25 | 00 | 44077                      | 86026        | 83240   | 55 | 00 | 31787                      | 98316        | 09082   |
| 25 | 30 | 0.43834                    | 4.86269      | 3.83749 | 55 | 30 | 0.31614                    | 4.98489      | 4.09455 |
| 26 | 00 | 43592                      | 86511        | 84250   | 56 | 00 | 31443                      | 98660        | 09822   |
| 26 | 30 | 43353                      | 86750        | 84748   | 56 | 30 | 31272                      | 98831        | 10188   |
| 27 | 00 | 43114                      | 86989        | 85242   | 57 | 00 | 31103                      | 99000        | 10555   |
| 27 | 30 | 42878                      | 87225        | 85734   | 57 | 30 | 30934                      | 99169        | 10911   |
| 28 | 00 | 42642                      | 87461        | 86243   | 58 | 00 | 30766                      | 99337        | 11277   |
| 28 | 30 | 42409                      | 87694        | 86709   | 58 | 30 | 30599                      | 99504        | 11633   |
| 29 | 00 | 42176                      | 87927        | 87192   | 59 | 00 | 30433                      | 99670        | 11990   |
| 29 | 30 | 41945                      | 88158        | 87672   | 59 | 30 | 30268                      | 99835        | 12344   |
| 30 | 00 | 41716                      | 88387        | 88150   | 60 | 00 | 30103                      | 5.00000      | 12700   |

TABLE VI. For finding the Latitude, by Two Altitudes of the Sun,

## A TABLE for finding the 2 HOURS.

| M. | S. | Elapf. Time. | Middle Time. | Rising. | M. | S. | Elapf. Time. | Middle Time. | Rising. |
|----|----|--------------|--------------|---------|----|----|--------------|--------------|---------|
| 00 | 30 | 0.29939      | 5.00164      | 4.13055 | 30 | 30 | 0.21432      | 5.08671      | 4.31801 |
| 01 | 00 | 29776        | 00327        | 13406   | 31 | 00 | 21309        | 08794        | 32079   |
| 01 | 30 | 29614        | 00489        | 13756   | 31 | 30 | 21187        | 08916        | 32355   |
| 02 | 00 | 29453        | 00650        | 14104   | 32 | 00 | 21066        | 09037        | 32631   |
| 02 | 30 | 29293        | 00810        | 14451   | 32 | 30 | 20945        | 09158        | 32906   |
| 03 | 00 | 29133        | 00970        | 14797   | 33 | 00 | 20824        | 09279        | 33180   |
| 03 | 30 | 28974        | 01129        | 15140   | 33 | 30 | 20704        | 09399        | 33452   |
| 04 | 00 | 28816        | 01287        | 15483   | 34 | 00 | 20585        | 09510        | 33724   |
| 04 | 30 | 28659        | 01444        | 15824   | 34 | 30 | 20466        | 09637        | 33995   |
| 05 | 00 | 28502        | 01601        | 16163   | 35 | 00 | 20348        | 09755        | 34265   |
| 05 | 30 | 0.28346      | 5.01757      | 4.16501 | 35 | 30 | 0.20230      | 5.09873      | 4.34534 |
| 06 | 00 | 28191        | 01912        | 16838   | 36 | 00 | 20113        | 09990        | 34802   |
| 06 | 30 | 28037        | 02066        | 17173   | 36 | 30 | 19996        | 10107        | 35069   |
| 07 | 00 | 27884        | 02219        | 17507   | 37 | 00 | 19880        | 10223        | 35335   |
| 07 | 30 | 27731        | 02372        | 17839   | 37 | 30 | 19764        | 10339        | 35600   |
| 08 | 00 | 27579        | 02524        | 18171   | 38 | 00 | 19648        | 10454        | 35865   |
| 08 | 30 | 27428        | 02675        | 18500   | 38 | 30 | 19534        | 10569        | 36128   |
| 09 | 00 | 27277        | 02826        | 18829   | 39 | 00 | 19420        | 10683        | 36391   |
| 09 | 30 | 27127        | 02976        | 19156   | 39 | 30 | 19306        | 10797        | 36652   |
| 10 | 00 | 26978        | 03125        | 19482   | 40 | 00 | 19193        | 10910        | 36913   |
| 10 | 30 | 0.26830      | 5.03275      | 4.19806 | 40 | 30 | 0.19080      | 5.11023      | 4.37173 |
| 11 | 00 | 26682        | 03421        | 20129   | 41 | 00 | 18968        | 11135        | 37432   |
| 11 | 30 | 26535        | 03568        | 20451   | 41 | 30 | 18857        | 11246        | 37690   |
| 12 | 00 | 26389        | 03714        | 20771   | 42 | 00 | 18746        | 11357        | 37948   |
| 12 | 30 | 26244        | 03859        | 21091   | 42 | 30 | 18635        | 11468        | 38204   |
| 13 | 00 | 26099        | 04004        | 21409   | 43 | 00 | 18525        | 11578        | 38460   |
| 13 | 30 | 25955        | 04148        | 21725   | 43 | 30 | 18415        | 11688        | 38714   |
| 14 | 00 | 25811        | 04292        | 22041   | 44 | 00 | 18306        | 11797        | 38968   |
| 14 | 30 | 25668        | 04435        | 22355   | 44 | 30 | 18197        | 11906        | 39221   |
| 15 | 00 | 25526        | 04577        | 22668   | 45 | 00 | 18089        | 12014        | 39473   |
| 15 | 30 | 0.25385      | 5.04718      | 4.22980 | 45 | 30 | 0.17981      | 5.12122      | 4.39724 |
| 16 | 00 | 25244        | 04859        | 23290   | 46 | 00 | 17874        | 12229        | 39975   |
| 16 | 30 | 25104        | 04999        | 23599   | 46 | 30 | 17767        | 12336        | 40225   |
| 17 | 00 | 24964        | 05139        | 23907   | 47 | 00 | 17660        | 12443        | 40474   |
| 17 | 30 | 24825        | 05278        | 24214   | 47 | 30 | 17554        | 12549        | 40722   |
| 18 | 00 | 24687        | 05416        | 24520   | 48 | 00 | 17449        | 12654        | 40969   |
| 18 | 30 | 24550        | 05553        | 24825   | 48 | 30 | 17344        | 12759        | 41215   |
| 19 | 00 | 24413        | 05690        | 25128   | 49 | 00 | 17239        | 12864        | 41461   |
| 19 | 30 | 24277        | 05826        | 25430   | 49 | 30 | 17135        | 12968        | 41706   |
| 20 | 00 | 24141        | 05962        | 25731   | 50 | 00 | 17031        | 13071        | 41950   |
| 20 | 30 | 0.24006      | 5.06097      | 3.26031 | 50 | 30 | 0.16928      | 5.13174      | 4.42193 |
| 21 | 00 | 23871        | 06232        | 26330   | 51 | 00 | 16826        | 13277        | 42435   |
| 21 | 30 | 23738        | 06365        | 26628   | 51 | 30 | 16724        | 13379        | 42677   |
| 22 | 00 | 23605        | 06498        | 26924   | 52 | 00 | 16622        | 13481        | 42918   |
| 22 | 30 | 23472        | 06631        | 27220   | 52 | 30 | 16520        | 13583        | 43158   |
| 23 | 00 | 23340        | 06763        | 27514   | 53 | 00 | 16419        | 13684        | 43398   |
| 23 | 30 | 23209        | 06894        | 27807   | 53 | 30 | 16319        | 13784        | 43636   |
| 24 | 00 | 23078        | 07025        | 28099   | 54 | 00 | 16219        | 13884        | 43874   |
| 24 | 30 | 22948        | 07155        | 28391   | 54 | 30 | 16119        | 13984        | 44111   |
| 25 | 00 | 22819        | 07284        | 28681   | 55 | 00 | 16029        | 14083        | 44348   |
| 25 | 30 | 0.22690      | 5.07413      | 4.28969 | 55 | 30 | 0.15921      | 5.14182      | 4.44583 |
| 26 | 00 | 22561        | 07542        | 29257   | 56 | 00 | 15823        | 14280        | 44818   |
| 26 | 30 | 22433        | 07670        | 29544   | 56 | 30 | 15725        | 14378        | 45052   |
| 27 | 00 | 22306        | 07797        | 29830   | 57 | 00 | 15627        | 14476        | 45286   |
| 27 | 30 | 22180        | 07923        | 30115   | 57 | 30 | 15530        | 14573        | 45518   |
| 28 | 00 | 22054        | 08049        | 30398   | 58 | 00 | 15434        | 14669        | 45750   |
| 28 | 30 | 21928        | 08175        | 30681   | 58 | 30 | 15338        | 14765        | 45981   |
| 29 | 00 | 21803        | 08300        | 30963   | 59 | 00 | 15242        | 14861        | 46212   |
| 29 | 30 | 21679        | 08424        | 31244   | 59 | 30 | 15146        | 14957        | 46442   |
| 30 | 00 | 21555        | 08548        | 31523   | 60 | 00 | 15051        | 15052        | 46671   |



TABLE VI. For finding the Latitude, by Two Altitudes of the Sun.

## LATITUDE by Two Altitudes. 3 HOURS

| M. | S. | $\frac{1}{2}$ Elapf. Time. | Middle Time. | Rising. | M. | S. | $\frac{1}{2}$ Elapf. Time. | Middle Time. | Rising. | M. |
|----|----|----------------------------|--------------|---------|----|----|----------------------------|--------------|---------|----|
| 0  | 30 | 0.14957                    | 5.15146      | 4.46899 | 30 | 30 | 0.09981                    | 5.20122      | 4.59436 | 00 |
| 1  | 00 | 14863                      | 15240        | 47127   | 31 | 00 | 09909                      | 20194        | 59627   | 01 |
| 1  | 30 | 14769                      | 15334        | 47354   | 31 | 30 | 09837                      | 20266        | 59818   | 01 |
| 2  | 00 | 14676                      | 15427        | 47580   | 32 | 00 | 09766                      | 20338        | 60008   | 02 |
| 2  | 30 | 14583                      | 15520        | 47806   | 32 | 30 | 09694                      | 20409        | 60198   | 02 |
| 3  | 00 | 14490                      | 15613        | 48031   | 33 | 00 | 09623                      | 20480        | 60388   | 03 |
| 3  | 30 | 14398                      | 15705        | 48255   | 33 | 30 | 09552                      | 20551        | 60577   | 03 |
| 4  | 00 | 14306                      | 15797        | 48479   | 34 | 00 | 09482                      | 20621        | 60765   | 04 |
| 4  | 30 | 14215                      | 15888        | 48702   | 34 | 30 | 09412                      | 20691        | 60952   | 04 |
| 5  | 00 | 14124                      | 15979        | 48924   | 35 | 00 | 09342                      | 20760        | 61139   | 05 |
| 5  | 30 | 0.14034                    | 5.16069      | 4.49145 | 35 | 30 | 0.09273                    | 5.20830      | 4.61320 | 05 |
| 6  | 00 | 13944                      | 16159        | 49366   | 36 | 00 | 09204                      | 20899        | 61512   | 06 |
| 6  | 30 | 13854                      | 16249        | 49586   | 36 | 30 | 09135                      | 20968        | 61698   | 06 |
| 7  | 00 | 13765                      | 16338        | 49806   | 37 | 00 | 09067                      | 21036        | 61884   | 07 |
| 7  | 30 | 13676                      | 16427        | 50025   | 37 | 30 | 08999                      | 21104        | 62068   | 07 |
| 8  | 00 | 13587                      | 16516        | 50243   | 38 | 00 | 08931                      | 21172        | 62251   | 08 |
| 8  | 30 | 13499                      | 16604        | 50460   | 38 | 30 | 08864                      | 21239        | 62433   | 08 |
| 9  | 00 | 13411                      | 16692        | 50677   | 39 | 00 | 08797                      | 21306        | 62615   | 09 |
| 9  | 30 | 13324                      | 16779        | 50893   | 39 | 30 | 08730                      | 21373        | 62802   | 09 |
| 10 | 00 | 13237                      | 16866        | 51109   | 40 | 00 | 08664                      | 21439        | 62984   | 10 |
| 10 | 30 | 0.13150                    | 5.16953      | 4.51324 | 40 | 30 | 0.08597                    | 5.21505      | 4.63166 | 10 |
| 11 | 00 | 13064                      | 17039        | 51539   | 41 | 00 | 08531                      | 21571        | 63347   | 11 |
| 11 | 30 | 12971                      | 17125        | 51753   | 41 | 30 | 08466                      | 21637        | 63528   | 11 |
| 12 | 00 | 12893                      | 17210        | 51966   | 42 | 00 | 08401                      | 21702        | 63708   | 12 |
| 12 | 30 | 12808                      | 17295        | 52178   | 42 | 30 | 08336                      | 21767        | 63888   | 12 |
| 13 | 00 | 12723                      | 17380        | 52390   | 43 | 00 | 08271                      | 21832        | 64068   | 13 |
| 13 | 30 | 12638                      | 17465        | 52601   | 43 | 30 | 08207                      | 21896        | 64248   | 13 |
| 14 | 00 | 12554                      | 17549        | 52812   | 44 | 00 | 08143                      | 21960        | 64428   | 14 |
| 14 | 30 | 12471                      | 17633        | 53022   | 44 | 30 | 08079                      | 22025        | 64608   | 14 |
| 15 | 00 | 12387                      | 17716        | 53231   | 45 | 00 | 08015                      | 22088        | 64788   | 15 |
| 15 | 30 | 0.12305                    | 5.17799      | 4.53440 | 45 | 30 | 0.07952                    | 5.22151      | 4.64951 | 15 |
| 16 | 00 | 12222                      | 17881        | 53648   | 46 | 00 | 07889                      | 22214        | 65131   | 16 |
| 16 | 30 | 12140                      | 17963        | 53856   | 46 | 30 | 07827                      | 22276        | 65311   | 16 |
| 17 | 00 | 12058                      | 18045        | 54063   | 47 | 00 | 07765                      | 22338        | 65488   | 17 |
| 17 | 30 | 11977                      | 18126        | 54269   | 47 | 30 | 07703                      | 22400        | 65668   | 17 |
| 18 | 00 | 11896                      | 18207        | 54475   | 48 | 00 | 07641                      | 22462        | 65848   | 18 |
| 18 | 30 | 11815                      | 18288        | 54680   | 48 | 30 | 07579                      | 22524        | 66018   | 18 |
| 19 | 00 | 11734                      | 18369        | 54885   | 49 | 00 | 07518                      | 22585        | 66188   | 19 |
| 19 | 30 | 11654                      | 18449        | 55089   | 49 | 30 | 07457                      | 22646        | 66358   | 19 |
| 20 | 00 | 11574                      | 18529        | 55293   | 50 | 00 | 07397                      | 22707        | 66533   | 20 |
| 20 | 30 | 0.11495                    | 5.18608      | 4.55496 | 50 | 30 | 0.07337                    | 5.22766      | 4.66700 | 20 |
| 21 | 00 | 11416                      | 18687        | 55698   | 51 | 00 | 07277                      | 22826        | 66877   | 21 |
| 21 | 30 | 11337                      | 18766        | 55900   | 51 | 30 | 07217                      | 22886        | 67047   | 21 |
| 22 | 00 | 11259                      | 18844        | 56101   | 52 | 00 | 07158                      | 22945        | 67217   | 22 |
| 22 | 30 | 11181                      | 18922        | 56301   | 52 | 30 | 07099                      | 23004        | 67387   | 22 |
| 23 | 00 | 11104                      | 18999        | 56501   | 53 | 00 | 07040                      | 23062        | 67557   | 23 |
| 23 | 30 | 11027                      | 19076        | 56701   | 53 | 30 | 06981                      | 23123        | 67727   | 23 |
| 24 | 00 | 10950                      | 19153        | 56900   | 54 | 00 | 06923                      | 23180        | 67897   | 24 |
| 24 | 30 | 10873                      | 19230        | 57098   | 54 | 30 | 06865                      | 23238        | 68067   | 24 |
| 25 | 00 | 10797                      | 19306        | 57296   | 55 | 00 | 06808                      | 23295        | 68237   | 25 |
| 25 | 30 | 0.10721                    | 5.19382      | 4.57494 | 55 | 30 | 0.06751                    | 5.23352      | 4.68400 | 25 |
| 26 | 00 | 10645                      | 19458        | 57690   | 56 | 00 | 06694                      | 23409        | 68577   | 26 |
| 26 | 30 | 10570                      | 19533        | 57886   | 56 | 30 | 06637                      | 23466        | 68757   | 26 |
| 27 | 00 | 10495                      | 19608        | 58082   | 57 | 00 | 06580                      | 23523        | 68937   | 27 |
| 27 | 30 | 10421                      | 19682        | 58277   | 57 | 30 | 06524                      | 23579        | 69117   | 27 |
| 28 | 00 | 10347                      | 19756        | 58471   | 58 | 00 | 06468                      | 23635        | 69297   | 28 |
| 28 | 30 | 10273                      | 19830        | 58665   | 58 | 30 | 06412                      | 23691        | 69477   | 28 |
| 29 | 00 | 10199                      | 19904        | 58859   | 59 | 00 | 06357                      | 23746        | 69657   | 29 |
| 29 | 30 | 10126                      | 19977        | 59052   | 59 | 30 | 06302                      | 23801        | 69837   | 29 |
| 30 | 00 | 10053                      | 20050        | 59244   | 60 | 00 | 06247                      | 23856        | 69997   | 30 |

TABLE VI. For finding the Latitude, by Two Altitudes of the Sun.

## A TABLE for finding the 4 HOURS.

| M. | S. | $\frac{1}{2}$ Elapf. Time. | Middle Time. | Rising. | M. | S. | $\frac{1}{2}$ Elapf. Time. | Middle Time. | Rising. |
|----|----|----------------------------|--------------|---------|----|----|----------------------------|--------------|---------|
| 00 | 30 | 0.06192                    | 5.23911      | 4.70061 | 30 | 30 | 0.03399                    | 5.26704      | 4.79193 |
| 01 | 00 | 06138                      | 23965        | 70224   | 31 | 00 | 03360                      | 26743        | 79334   |
| 01 | 30 | 06084                      | 24019        | 70387   | 31 | 30 | 03321                      | 26782        | 79475   |
| 02 | 00 | 06030                      | 24073        | 70550   | 32 | 00 | 03283                      | 26820        | 79616   |
| 02 | 30 | 05977                      | 24126        | 70712   | 32 | 30 | 03245                      | 26858        | 79756   |
| 03 | 00 | 05924                      | 24179        | 70874   | 33 | 00 | 03207                      | 26896        | 79896   |
| 03 | 30 | 05871                      | 24232        | 71036   | 33 | 30 | 03170                      | 26934        | 80036   |
| 04 | 00 | 05818                      | 24285        | 71197   | 34 | 00 | 03132                      | 26971        | 80175   |
| 04 | 30 | 05766                      | 24337        | 71357   | 34 | 30 | 03095                      | 27008        | 80314   |
| 05 | 00 | 05714                      | 24389        | 71518   | 35 | 00 | 03058                      | 27045        | 80452   |
| 05 | 30 | 0.05662                    | 5.24441      | 4.71678 | 35 | 30 | 0.03021                    | 5.27082      | 4.80591 |
| 06 | 00 | 05610                      | 24493        | 71837   | 36 | 00 | 02985                      | 27118        | 80729   |
| 06 | 30 | 05559                      | 24544        | 71996   | 36 | 30 | 02949                      | 27154        | 80867   |
| 07 | 00 | 05508                      | 24595        | 72155   | 37 | 00 | 02913                      | 27190        | 81004   |
| 07 | 30 | 05457                      | 24646        | 72313   | 37 | 30 | 02877                      | 27226        | 81141   |
| 08 | 00 | 05406                      | 24697        | 72471   | 38 | 00 | 02841                      | 27262        | 81278   |
| 08 | 30 | 05356                      | 24747        | 72628   | 38 | 30 | 02806                      | 27297        | 81414   |
| 09 | 00 | 05306                      | 24797        | 72786   | 39 | 00 | 02771                      | 27332        | 81550   |
| 09 | 30 | 05256                      | 24847        | 72942   | 39 | 30 | 02736                      | 27367        | 81686   |
| 10 | 00 | 05207                      | 24897        | 73098   | 40 | 00 | 02701                      | 27402        | 81821   |
| 10 | 30 | 0.05158                    | 5.24945      | 4.73254 | 40 | 30 | 0.02667                    | 5.27436      | 4.81956 |
| 11 | 00 | 05109                      | 24994        | 73410   | 41 | 00 | 02633                      | 27470        | 82091   |
| 11 | 30 | 05060                      | 25043        | 73565   | 41 | 30 | 02599                      | 27504        | 82226   |
| 12 | 00 | 05012                      | 25091        | 73720   | 42 | 00 | 02565                      | 27538        | 82360   |
| 12 | 30 | 04964                      | 25139        | 73874   | 42 | 30 | 02532                      | 27571        | 82494   |
| 13 | 00 | 04916                      | 25187        | 74028   | 43 | 00 | 02499                      | 27604        | 82628   |
| 13 | 30 | 04868                      | 25235        | 74182   | 43 | 30 | 02466                      | 27637        | 82761   |
| 14 | 00 | 04821                      | 25282        | 74335   | 44 | 00 | 02433                      | 27670        | 82894   |
| 14 | 30 | 04774                      | 25329        | 74488   | 44 | 30 | 02400                      | 27703        | 83027   |
| 15 | 00 | 04727                      | 25376        | 74641   | 45 | 00 | 02368                      | 27735        | 83159   |
| 15 | 30 | 0.04680                    | 5.25423      | 4.74793 | 45 | 30 | 0.02336                    | 5.27767      | 4.83291 |
| 16 | 00 | 04634                      | 25469        | 74945   | 46 | 00 | 02304                      | 27799        | 83423   |
| 16 | 30 | 04588                      | 25515        | 75096   | 46 | 30 | 02272                      | 27831        | 83554   |
| 17 | 00 | 04542                      | 25561        | 75247   | 47 | 00 | 02241                      | 27862        | 83685   |
| 17 | 30 | 04496                      | 25607        | 75398   | 47 | 30 | 02210                      | 27893        | 83816   |
| 18 | 00 | 04451                      | 25652        | 75549   | 48 | 00 | 02179                      | 27924        | 83947   |
| 18 | 30 | 04406                      | 25697        | 75699   | 48 | 30 | 02148                      | 27955        | 84077   |
| 19 | 00 | 04361                      | 25742        | 75848   | 49 | 00 | 02118                      | 27985        | 84207   |
| 19 | 30 | 04316                      | 25787        | 75997   | 49 | 30 | 02088                      | 28015        | 84337   |
| 20 | 00 | 04272                      | 25831        | 76146   | 50 | 00 | 02058                      | 28045        | 84466   |
| 20 | 30 | 0.04228                    | 5.25875      | 4.76295 | 50 | 30 | 0.02028                    | 5.28075      | 4.84595 |
| 21 | 00 | 04184                      | 25919        | 76443   | 51 | 00 | 01998                      | 28105        | 84724   |
| 21 | 30 | 04141                      | 25962        | 76591   | 51 | 30 | 01969                      | 28134        | 84853   |
| 22 | 00 | 04098                      | 26005        | 76738   | 52 | 00 | 01940                      | 28163        | 84981   |
| 22 | 30 | 04055                      | 26048        | 76885   | 52 | 30 | 01911                      | 28192        | 85109   |
| 23 | 00 | 04012                      | 26091        | 77032   | 53 | 00 | 01882                      | 28221        | 85236   |
| 23 | 30 | 03969                      | 26134        | 77179   | 53 | 30 | 01854                      | 28249        | 85363   |
| 24 | 00 | 03927                      | 26176        | 77325   | 54 | 00 | 01826                      | 28277        | 85490   |
| 24 | 30 | 03885                      | 26218        | 77471   | 54 | 30 | 01798                      | 28305        | 85617   |
| 25 | 00 | 03843                      | 26260        | 77616   | 55 | 00 | 01770                      | 28333        | 85744   |
| 25 | 30 | 0.03801                    | 5.26302      | 4.77761 | 55 | 30 | 0.01743                    | 5.28360      | 4.85870 |
| 26 | 00 | 03760                      | 26343        | 77906   | 56 | 00 | 01716                      | 28387        | 85996   |
| 26 | 30 | 03719                      | 26384        | 78050   | 56 | 30 | 01689                      | 28414        | 86121   |
| 27 | 00 | 03678                      | 26425        | 78194   | 57 | 00 | 01662                      | 28441        | 86246   |
| 27 | 30 | 03638                      | 26466        | 78338   | 57 | 30 | 01635                      | 28468        | 86371   |
| 28 | 00 | 03597                      | 26506        | 78481   | 58 | 00 | 01609                      | 28494        | 86496   |
| 28 | 30 | 03557                      | 26546        | 78624   | 58 | 30 | 01583                      | 28520        | 86621   |
| 29 | 00 | 03517                      | 26586        | 78767   | 59 | 00 | 01557                      | 28546        | 86745   |
| 29 | 30 | 03478                      | 26626        | 78909   | 59 | 30 | 01531                      | 28572        | 86869   |
| 30 | 00 | 03438                      | 26665        | 79051   | 60 | 00 | 01505                      | 28598        | 86993   |

TABLE VI. For finding the Latitude, by Two Altitudes of the Sun.

## LATITUDE by Two Altitudes 5 HOURS.

| M. | S. | $\frac{1}{2}$ Elapf. Time. | Middle Time. | Rising. | M. | S. | $\frac{1}{2}$ Elapf. Time. | Middle Time. | Rising. |
|----|----|----------------------------|--------------|---------|----|----|----------------------------|--------------|---------|
| 0  | 30 | 0.01480                    | 5.28623      | 4.87816 | 30 | 30 | 0.00361                    | 5.29742      | 4.94031 |
| 1  | 00 | 01455                      | 28648        | 87239   | 31 | 00 | 00349                      | 29754        | 94144   |
| 1  | 30 | 01430                      | 28673        | 87362   | 31 | 30 | 00337                      | 29766        | 94244   |
| 2  | 00 | 01405                      | 28698        | 87484   | 32 | 00 | 00325                      | 29778        | 94350   |
| 2  | 30 | 01381                      | 28722        | 87606   | 32 | 30 | 00313                      | 29790        | 94461   |
| 3  | 00 | 01357                      | 28746        | 87728   | 33 | 00 | 00302                      | 29801        | 94570   |
| 3  | 30 | 01333                      | 28770        | 87850   | 33 | 30 | 00291                      | 29812        | 94676   |
| 4  | 00 | 01309                      | 28794        | 87971   | 34 | 00 | 00280                      | 29823        | 94782   |
| 4  | 30 | 01286                      | 28817        | 88092   | 34 | 30 | 00269                      | 29834        | 94888   |
| 5  | 00 | 01263                      | 28840        | 88213   | 35 | 00 | 00259                      | 29844        | 94994   |
| 5  | 30 | 0.01240                    | 5.28863      | 4.88334 | 35 | 30 | 0.00249                    | 5.29854      | 4.95100 |
| 6  | 00 | 01217                      | 28886        | 88454   | 36 | 00 | 00239                      | 29864        | 95205   |
| 6  | 30 | 01194                      | 28909        | 88574   | 36 | 30 | 00229                      | 29874        | 95310   |
| 7  | 00 | 01172                      | 28931        | 88694   | 37 | 00 | 00219                      | 29884        | 95415   |
| 7  | 30 | 01150                      | 28953        | 88814   | 37 | 30 | 00209                      | 29894        | 95520   |
| 8  | 00 | 01128                      | 28975        | 88933   | 38 | 00 | 00200                      | 29903        | 95624   |
| 8  | 30 | 01106                      | 28997        | 89052   | 38 | 30 | 00191                      | 29912        | 95728   |
| 9  | 00 | 01084                      | 29019        | 89171   | 39 | 00 | 00182                      | 29911        | 95832   |
| 9  | 30 | 01063                      | 29040        | 89289   | 39 | 30 | 00174                      | 29920        | 95936   |
| 10 | 00 | 01042                      | 29061        | 89407   | 40 | 00 | 00166                      | 29937        | 96040   |
| 10 | 30 | 0.01021                    | 5.29082      | 4.89525 | 40 | 30 | 0.00157                    | 5.29945      | 4.96143 |
| 11 | 00 | 01000                      | 29103        | 89643   | 41 | 00 | 00150                      | 29953        | 96246   |
| 11 | 30 | 00980                      | 29123        | 89760   | 41 | 30 | 00142                      | 29961        | 96349   |
| 12 | 00 | 00960                      | 29143        | 89877   | 42 | 00 | 00134                      | 29969        | 96452   |
| 12 | 30 | 00940                      | 29163        | 89994   | 42 | 30 | 00127                      | 29976        | 96554   |
| 13 | 00 | 00920                      | 29183        | 90111   | 43 | 00 | 00120                      | 29983        | 96656   |
| 13 | 30 | 00900                      | 29203        | 90227   | 43 | 30 | 00113                      | 29990        | 96758   |
| 14 | 00 | 00881                      | 29222        | 90343   | 44 | 00 | 00106                      | 29997        | 96860   |
| 14 | 30 | 00862                      | 29241        | 90459   | 44 | 30 | 00099                      | 30004        | 96961   |
| 15 | 00 | 00843                      | 29260        | 90575   | 45 | 00 | 00093                      | 30010        | 97062   |
| 15 | 30 | 0.00824                    | 5.29279      | 4.90690 | 45 | 30 | 0.00817                    | 5.30016      | 4.97163 |
| 16 | 00 | 00805                      | 29298        | 90805   | 46 | 00 | 00811                      | 30022        | 97264   |
| 16 | 30 | 00787                      | 29316        | 90920   | 46 | 30 | 00805                      | 30028        | 97365   |
| 17 | 00 | 00769                      | 29334        | 91035   | 47 | 00 | 00800                      | 30033        | 97465   |
| 17 | 30 | 00751                      | 29352        | 91149   | 47 | 30 | 00805                      | 30038        | 97565   |
| 18 | 00 | 00733                      | 29370        | 91263   | 48 | 00 | 00800                      | 30043        | 97665   |
| 18 | 30 | 00716                      | 29387        | 91377   | 48 | 30 | 00805                      | 30048        | 97765   |
| 19 | 00 | 00699                      | 29404        | 91490   | 49 | 00 | 00800                      | 30053        | 97865   |
| 19 | 30 | 00682                      | 29421        | 91603   | 49 | 30 | 00804                      | 30058        | 97964   |
| 20 | 00 | 0.00665                    | 5.29438      | 4.91716 | 50 | 00 | 00841                      | 30062        | 98063   |
| 20 | 30 | 0.00648                    | 5.29455      | 4.91829 | 50 | 30 | 0.00837                    | 5.30066      | 4.98162 |
| 21 | 00 | 00632                      | 29471        | 91942   | 51 | 00 | 00833                      | 30070        | 98261   |
| 21 | 30 | 00616                      | 29487        | 92054   | 51 | 30 | 00829                      | 30074        | 98359   |
| 22 | 00 | 00600                      | 29503        | 92166   | 52 | 00 | 00826                      | 30077        | 98457   |
| 22 | 30 | 00584                      | 29519        | 92278   | 52 | 30 | 00823                      | 30080        | 98555   |
| 23 | 00 | 00568                      | 29535        | 92390   | 53 | 00 | 00820                      | 30083        | 98653   |
| 23 | 30 | 00553                      | 29550        | 92501   | 53 | 30 | 00817                      | 30086        | 98751   |
| 24 | 00 | 00538                      | 29565        | 92612   | 54 | 00 | 00815                      | 30088        | 98848   |
| 24 | 30 | 00523                      | 29580        | 92723   | 54 | 30 | 00812                      | 30090        | 98945   |
| 25 | 00 | 00508                      | 29595        | 92834   | 55 | 00 | 00810                      | 30092        | 99042   |
| 25 | 30 | 0.00494                    | 5.29609      | 4.92944 | 55 | 30 | 0.00808                    | 5.30094      | 4.99139 |
| 26 | 00 | 00480                      | 29623        | 93054   | 56 | 00 | 00807                      | 30096        | 99236   |
| 26 | 30 | 00466                      | 29637        | 93164   | 56 | 30 | 00805                      | 30098        | 99332   |
| 27 | 00 | 00452                      | 29651        | 93274   | 57 | 00 | 00804                      | 30099        | 99428   |
| 27 | 30 | 00438                      | 29665        | 93383   | 57 | 30 | 00803                      | 30100        | 99524   |
| 28 | 00 | 00425                      | 29678        | 93492   | 58 | 00 | 00802                      | 30101        | 99620   |
| 28 | 30 | 00412                      | 29691        | 93601   | 58 | 30 | 00801                      | 30102        | 99715   |
| 29 | 00 | 00399                      | 29704        | 93709   | 59 | 00 | 00800                      | 30103        | 99810   |
| 29 | 30 | 00386                      | 29717        | 93817   | 59 | 30 | 00800                      | 30103        | 99905   |
| 30 | 00 | 00373                      | 29730        | 93925   | 60 | 00 | 00800                      | 30105        | 5.00000 |



Sun.

| 6 Hours. |    |              |    |    |              | 7 Hours. |    |              |    |    |              | 8 Hours. |    |              |    |    |              |
|----------|----|--------------|----|----|--------------|----------|----|--------------|----|----|--------------|----------|----|--------------|----|----|--------------|
| M        | S. | Log. Rifing. | M  | S. | Log. Rifing. | M        | S. | Log. Rifing. | M  | S. | Log. Rifing. | M        | S. | Log. Rifing. | M  | S. | Log. Rifing. |
| 0        | 30 | 5,06094      | 30 | 30 | 5,05410      | 0        | 30 | 5,10068      | 30 | 30 | 5,14134      | 0        | 30 | 5,17663      | 30 | 30 | 5,20695      |
| 1        | 00 | 00188        | 31 | 00 | 05493        | 1        | 00 | 10140        | 31 | 00 | 14198        | 1        | 00 | 17717        | 31 | 00 | 20742        |
| 1        | 30 | 00282        | 31 | 30 | 05576        | 1        | 30 | 10212        | 31 | 30 | 14261        | 1        | 30 | 17772        | 31 | 30 | 20788        |
| 2        | 00 | 00376        | 32 | 00 | 05659        | 2        | 00 | 10284        | 32 | 00 | 14324        | 2        | 00 | 17826        | 32 | 00 | 20835        |
| 2        | 30 | 00469        | 32 | 30 | 05740        | 2        | 30 | 10356        | 32 | 30 | 14386        | 2        | 30 | 17880        | 32 | 30 | 20881        |
| 3        | 00 | 00563        | 33 | 00 | 05822        | 3        | 00 | 10429        | 33 | 00 | 14449        | 3        | 00 | 17934        | 33 | 00 | 20927        |
| 3        | 30 | 00657        | 33 | 30 | 05904        | 3        | 30 | 10501        | 33 | 30 | 14511        | 3        | 30 | 17988        | 33 | 30 | 20972        |
| 4        | 00 | 00751        | 34 | 00 | 05985        | 4        | 00 | 10573        | 34 | 00 | 14573        | 4        | 00 | 18042        | 34 | 00 | 21018        |
| 4        | 30 | 00844        | 34 | 30 | 06067        | 4        | 30 | 10643        | 34 | 30 | 14635        | 4        | 30 | 18095        | 34 | 30 | 21063        |
| 5        | 00 | 00936        | 35 | 00 | 06149        | 5        | 00 | 10714        | 35 | 00 | 14697        | 5        | 00 | 18148        | 35 | 00 | 21109        |
| 5        | 30 | 01028        | 35 | 30 | 06230        | 5        | 30 | 10785        | 35 | 30 | 14759        | 5        | 30 | 18202        | 35 | 30 | 21155        |
| 6        | 00 | 01121        | 36 | 00 | 06312        | 6        | 00 | 10856        | 36 | 00 | 14821        | 6        | 00 | 18255        | 36 | 00 | 21201        |
| 6        | 30 | 01213        | 36 | 30 | 06392        | 6        | 30 | 10926        | 36 | 30 | 14882        | 6        | 30 | 18308        | 36 | 30 | 21245        |
| 7        | 00 | 01305        | 37 | 00 | 06472        | 7        | 00 | 10997        | 37 | 00 | 14943        | 7        | 00 | 18361        | 37 | 00 | 21290        |
| 7        | 30 | 01398        | 37 | 30 | 06553        | 7        | 30 | 11068        | 37 | 30 | 15004        | 7        | 30 | 18414        | 37 | 30 | 21335        |
| 8        | 00 | 01490        | 38 | 00 | 06633        | 8        | 00 | 11139        | 38 | 00 | 15065        | 8        | 00 | 18467        | 38 | 00 | 21379        |
| 8        | 30 | 01580        | 38 | 30 | 06713        | 8        | 30 | 11208        | 38 | 30 | 15126        | 8        | 30 | 18519        | 38 | 30 | 21424        |
| 9        | 00 | 01671        | 39 | 00 | 06793        | 9        | 00 | 11278        | 39 | 00 | 15187        | 9        | 00 | 18571        | 39 | 00 | 21469        |
| 9        | 30 | 01762        | 39 | 30 | 06873        | 9        | 30 | 11347        | 39 | 30 | 15248        | 9        | 30 | 18623        | 39 | 30 | 21513        |
| 10       | 00 | 01853        | 40 | 00 | 06954        | 10       | 00 | 11417        | 40 | 00 | 15309        | 10       | 00 | 18675        | 40 | 00 | 21558        |
| 10       | 30 | 01943        | 40 | 30 | 07033        | 10       | 30 | 11486        | 40 | 30 | 15369        | 10       | 30 | 18727        | 40 | 30 | 21602        |
| 11       | 00 | 02034        | 41 | 00 | 07111        | 11       | 00 | 11556        | 41 | 00 | 15428        | 11       | 00 | 18779        | 41 | 00 | 21645        |
| 11       | 30 | 02125        | 41 | 30 | 07190        | 11       | 30 | 11625        | 41 | 30 | 15488        | 11       | 30 | 18831        | 41 | 30 | 21689        |
| 12       | 00 | 02215        | 42 | 00 | 07269        | 12       | 00 | 11694        | 42 | 00 | 15548        | 12       | 00 | 18883        | 42 | 00 | 21733        |
| 12       | 30 | 02304        | 42 | 30 | 07348        | 12       | 30 | 11763        | 42 | 30 | 15608        | 12       | 30 | 18934        | 42 | 30 | 21777        |
| 13       | 00 | 02394        | 43 | 00 | 07427        | 13       | 00 | 11831        | 43 | 00 | 15667        | 13       | 00 | 18985        | 43 | 00 | 21820        |
| 13       | 30 | 02483        | 43 | 30 | 07505        | 13       | 30 | 11899        | 43 | 30 | 15727        | 13       | 30 | 19035        | 43 | 30 | 21864        |
| 14       | 00 | 02572        | 44 | 00 | 07584        | 14       | 00 | 11967        | 44 | 00 | 15787        | 14       | 00 | 19086        | 44 | 00 | 21908        |
| 14       | 30 | 02661        | 44 | 30 | 07662        | 14       | 30 | 12036        | 44 | 30 | 15846        | 14       | 30 | 19137        | 44 | 30 | 21950        |
| 15       | 00 | 02750        | 45 | 00 | 07739        | 15       | 00 | 12104        | 45 | 00 | 15904        | 15       | 00 | 19188        | 45 | 00 | 21993        |
| 15       | 30 | 02839        | 45 | 30 | 07816        | 15       | 30 | 12172        | 45 | 30 | 15963        | 15       | 30 | 19239        | 45 | 30 | 22036        |
| 16       | 00 | 02928        | 46 | 00 | 07894        | 16       | 00 | 12240        | 46 | 00 | 16022        | 16       | 00 | 19290        | 46 | 00 | 22078        |
| 16       | 30 | 03016        | 46 | 30 | 07971        | 16       | 30 | 12307        | 46 | 30 | 16080        | 16       | 30 | 19340        | 46 | 30 | 22121        |
| 17       | 00 | 03104        | 47 | 00 | 08049        | 17       | 00 | 12374        | 47 | 00 | 16139        | 17       | 00 | 19390        | 47 | 00 | 22164        |
| 17       | 30 | 03191        | 47 | 30 | 08126        | 17       | 30 | 12441        | 47 | 30 | 16197        | 17       | 30 | 19440        | 47 | 30 | 22206        |
| 18       | 00 | 03279        | 48 | 00 | 08203        | 18       | 00 | 12508        | 48 | 00 | 16256        | 18       | 00 | 19489        | 48 | 00 | 22249        |
| 18       | 30 | 03366        | 48 | 30 | 08280        | 18       | 30 | 12575        | 48 | 30 | 16314        | 18       | 30 | 19539        | 48 | 30 | 22291        |
| 19       | 00 | 03454        | 49 | 00 | 08356        | 19       | 00 | 12642        | 49 | 00 | 16371        | 19       | 00 | 19589        | 49 | 00 | 22332        |
| 19       | 30 | 03542        | 49 | 30 | 08432        | 19       | 30 | 12709        | 49 | 30 | 16429        | 19       | 30 | 19639        | 49 | 30 | 22374        |
| 20       | 00 | 03629        | 50 | 00 | 08508        | 20       | 00 | 12776        | 50 | 00 | 16486        | 20       | 00 | 19689        | 50 | 00 | 22416        |
| 20       | 30 | 03715        | 50 | 30 | 08584        | 20       | 30 | 12841        | 50 | 30 | 16544        | 20       | 30 | 19738        | 50 | 30 | 22457        |
| 21       | 00 | 03801        | 51 | 00 | 08660        | 21       | 00 | 12907        | 51 | 00 | 16601        | 21       | 00 | 19786        | 51 | 00 | 22499        |
| 21       | 30 | 03887        | 51 | 30 | 08736        | 21       | 30 | 12973        | 51 | 30 | 16659        | 21       | 30 | 19835        | 51 | 30 | 22541        |
| 22       | 00 | 03974        | 52 | 00 | 08812        | 22       | 00 | 13039        | 52 | 00 | 16716        | 22       | 00 | 19884        | 52 | 00 | 22583        |
| 22       | 30 | 04060        | 52 | 30 | 08887        | 22       | 30 | 13104        | 52 | 30 | 16773        | 22       | 30 | 19933        | 52 | 30 | 22623        |
| 23       | 00 | 04146        | 53 | 00 | 08961        | 23       | 00 | 13170        | 53 | 00 | 16829        | 23       | 00 | 19982        | 53 | 00 | 22664        |
| 23       | 30 | 04232        | 53 | 30 | 09036        | 23       | 30 | 13236        | 53 | 30 | 16885        | 23       | 30 | 20030        | 53 | 30 | 22705        |
| 24       | 00 | 04318        | 54 | 00 | 09111        | 24       | 00 | 13302        | 54 | 00 | 16942        | 24       | 00 | 20079        | 54 | 00 | 22745        |
| 24       | 30 | 04402        | 54 | 30 | 09185        | 24       | 30 | 13366        | 54 | 30 | 16998        | 24       | 30 | 20127        | 54 | 30 | 22786        |
| 25       | 00 | 04487        | 55 | 00 | 09260        | 25       | 00 | 13431        | 55 | 00 | 17054        | 25       | 00 | 20175        | 55 | 00 | 22827        |
| 25       | 30 | 04571        | 55 | 30 | 09335        | 25       | 30 | 13495        | 55 | 30 | 17111        | 25       | 30 | 20222        | 55 | 30 | 22868        |
| 26       | 00 | 04656        | 56 | 00 | 09409        | 26       | 00 | 13560        | 56 | 00 | 17167        | 26       | 00 | 20270        | 56 | 00 | 22908        |
| 26       | 30 | 04740        | 56 | 30 | 09483        | 26       | 30 | 13624        | 56 | 30 | 17222        | 26       | 30 | 20318        | 56 | 30 | 22948        |
| 27       | 00 | 04825        | 57 | 00 | 09556        | 27       | 00 | 13689        | 57 | 00 | 17277        | 27       | 00 | 20366        | 57 | 00 | 22988        |
| 27       | 30 | 04910        | 57 | 30 | 09629        | 27       | 30 | 13753        | 57 | 30 | 17333        | 27       | 30 | 20413        | 57 | 30 | 23027        |
| 28       | 00 | 04994        | 58 | 00 | 09703        | 28       | 00 | 13818        | 58 | 00 | 17388        | 28       | 00 | 20461        | 58 | 00 | 23067        |
| 28       | 30 | 05077        | 58 | 30 | 09776        | 28       | 30 | 13881        | 58 | 30 | 17443        | 28       | 30 | 20508        | 58 | 30 | 23107        |
| 29       | 00 | 05160        | 59 | 00 | 09850        | 29       | 00 | 13944        | 59 | 00 | 17498        | 29       | 00 | 20555        | 59 | 00 | 23146        |
| 29       | 30 | 05243        | 59 | 30 | 09923        | 29       | 30 | 14008        | 59 | 30 | 17554        | 29       | 30 | 20601        | 59 | 30 | 23186        |
| 30       | 00 | 05327        | 60 | 00 | 09996        | 30       | 00 | 14071        | 60 | 00 | 17609        | 30       | 00 | 20648        |    |    |              |

TABLE VIII. OF NATURAL SINES.

|     | 0°      | 1°       | 2°      | 3°      | 4°      |         |
|-----|---------|----------|---------|---------|---------|---------|
| M.  | N. fine | N. col.  | N. fine | N. col. | N. fine | N. col. |
| 0   | 00      | 100000   | 1745    | 99985   | 3490    | 99939   |
| 1   | 29      | 0000     | 1774    | 984     | 3519    | 938     |
| 2   | 58      | 0000     | 1803    | 984     | 3548    | 937     |
| 3   | 87      | 0000     | 1832    | 983     | 3577    | 936     |
| 4   | 116     | 0000     | 1862    | 983     | 3606    | 935     |
| 5   | 145     | 0000     | 1891    | 982     | 3635    | 934     |
| 6   | 175     | 0000     | 1920    | 982     | 3664    | 933     |
| 7   | 204     | 100000   | 1949    | 99981   | 3693    | 99932   |
| 8   | 233     | 0000     | 1978    | 980     | 3723    | 931     |
| 9   | 262     | 0000     | 2007    | 980     | 3752    | 930     |
| 10  | 291     | 0000     | 2036    | 979     | 3781    | 929     |
| 11  | 320     | 99999    | 2065    | 979     | 3810    | 927     |
| 12  | 349     | 999      | 2094    | 978     | 3839    | 926     |
| 13  | 378     | 99999    | 2123    | 99977   | 3868    | 99925   |
| 14  | 407     | 999      | 2152    | 977     | 3897    | 924     |
| 15  | 436     | 999      | 2181    | 976     | 3926    | 923     |
| 16  | 465     | 999      | 2211    | 976     | 3955    | 922     |
| 17  | 495     | 999      | 2240    | 975     | 3984    | 921     |
| 18  | 524     | 999      | 2269    | 974     | 4013    | 919     |
| 19  | 553     | 99998    | 2298    | 99974   | 4042    | 99918   |
| 20  | 582     | 9998     | 2327    | 973     | 4071    | 917     |
| 21  | 611     | 9998     | 2356    | 972     | 4100    | 916     |
| 22  | 640     | 9998     | 2385    | 972     | 4129    | 915     |
| 23  | 669     | 9998     | 2414    | 971     | 4159    | 913     |
| 24  | 698     | 9998     | 2443    | 970     | 4188    | 912     |
| 25  | 727     | 99997    | 2472    | 99969   | 4217    | 99911   |
| 26  | 756     | 997      | 2501    | 969     | 4246    | 910     |
| 27  | 785     | 997      | 2530    | 968     | 4275    | 909     |
| 28  | 814     | 997      | 2560    | 967     | 4304    | 907     |
| 29  | 844     | 996      | 2589    | 966     | 4333    | 906     |
| 30  | 873     | 996      | 2618    | 966     | 4362    | 905     |
| 31  | 902     | 99996    | 2647    | 99965   | 4391    | 99904   |
| 32  | 931     | 996      | 2676    | 964     | 4420    | 902     |
| 33  | 960     | 995      | 2705    | 963     | 4449    | 901     |
| 34  | 989     | 995      | 2734    | 963     | 4478    | 900     |
| 35  | 1018    | 995      | 2763    | 962     | 4507    | 898     |
| 36  | 1047    | 995      | 2792    | 961     | 4536    | 897     |
| 37  | 1076    | 99994    | 2821    | 99960   | 4565    | 99896   |
| 38  | 1105    | 994      | 2850    | 959     | 4594    | 894     |
| 39  | 1134    | 994      | 2879    | 959     | 4623    | 893     |
| 40  | 1164    | 993      | 2908    | 958     | 4653    | 892     |
| 41  | 1193    | 993      | 2938    | 957     | 4682    | 890     |
| 42  | 1222    | 993      | 2967    | 956     | 4711    | 889     |
| 43  | 1251    | 99992    | 2996    | 99955   | 4740    | 99888   |
| 44  | 1280    | 992      | 3025    | 954     | 4769    | 886     |
| 45  | 1309    | 991      | 3054    | 953     | 4798    | 885     |
| 46  | 1338    | 991      | 3083    | 952     | 4827    | 883     |
| 47  | 1367    | 991      | 3112    | 952     | 4856    | 882     |
| 48  | 1396    | 990      | 3141    | 951     | 4885    | 881     |
| 49  | 1425    | 99990    | 3170    | 99950   | 4914    | 99879   |
| 50  | 1454    | 989      | 3199    | 949     | 4943    | 878     |
| 51  | 1483    | 989      | 3228    | 948     | 4972    | 876     |
| 52  | 1513    | 989      | 3257    | 947     | 5001    | 875     |
| 53  | 1542    | 988      | 3286    | 946     | 5030    | 873     |
| 54  | 1571    | 988      | 3316    | 945     | 5059    | 872     |
| 55  | 1600    | 99987    | 3345    | 99944   | 5088    | 99870   |
| 56  | 1629    | 987      | 3374    | 943     | 5117    | 869     |
| 57  | 1658    | 986      | 3403    | 942     | 5146    | 867     |
| 58  | 1687    | 986      | 3432    | 941     | 5175    | 866     |
| 59  | 1716    | 985      | 3461    | 940     | 5205    | 864     |
| M.  | N. col. | N. fine. | N. col. | N. fine | N. col. | N. fine |
|     |         |          |         |         |         |         |
| 89° |         |          | 88°     |         | 87°     |         |
| 86° |         |          | 85°     |         |         |         |

TABLE VIII. OF NATURAL SINES.

|    | 5°      | 6°      | 7°     | 8°      | 9°      |         |        |         |        |         |    |
|----|---------|---------|--------|---------|---------|---------|--------|---------|--------|---------|----|
| M. | N.fine  | N.col.  | N.fine | N.col.  | N.fine  | N.col.  | N.fine | N.col.  | N.fine | N.col.  | M. |
| 0  | 8716    | 99619   | 10453  | 99451   | 12187   | 99255   | 13917  | 99027   | 15643  | 98769   | 60 |
| 1  | 8745    | 617     | 482    | 4.9     | 216     | 251     | 946    | 023     | 672    | 764     | 59 |
| 2  | 8774    | 614     | 511    | 4.16    | 245     | 248     | 975    | 019     | 701    | 760     | 58 |
| 3  | 8803    | 612     | 540    | 443     | 274     | 244     | 14004  | 015     | 730    | 755     | 57 |
| 4  | 8831    | 609     | 569    | 440     | 302     | 240     | 033    | 011     | 758    | 751     | 56 |
| 5  | 8860    | 607     | 597    | 437     | 331     | 237     | 061    | 006     | 787    | 746     | 55 |
| 6  | 8889    | 604     | 626    | 434     | 360     | 233     | 090    | 002     | 816    | 741     | 54 |
| 7  | 8918    | 99602   | 10655  | 99431   | 12389   | 99230   | 14119  | 98998   | 15845  | 98737   | 53 |
| 8  | 8947    | 599     | 684    | 428     | 418     | 226     | 148    | 994     | 873    | 732     | 52 |
| 9  | 8976    | 596     | 713    | 424     | 447     | 222     | 177    | 990     | 902    | 728     | 51 |
| 10 | 9005    | 594     | 742    | 421     | 476     | 219     | 205    | 986     | 931    | 723     | 50 |
| 11 | 9034    | 591     | 771    | 418     | 504     | 215     | 234    | 982     | 959    | 718     | 49 |
| 12 | 9063    | 588     | 800    | 415     | 533     | 211     | 263    | 978     | 988    | 714     | 48 |
| 13 | 9092    | 99586   | 10829  | 99412   | 12562   | 99208   | 14292  | 98973   | 16017  | 98709   | 47 |
| 14 | 9121    | 583     | 858    | 409     | 591     | 204     | 320    | 969     | 046    | 704     | 46 |
| 15 | 9150    | 580     | 887    | 406     | 620     | 200     | 349    | 965     | 074    | 700     | 45 |
| 16 | 9179    | 578     | 916    | 402     | 649     | 197     | 378    | 961     | 103    | 695     | 44 |
| 17 | 9208    | 575     | 945    | 399     | 678     | 193     | 407    | 957     | 132    | 690     | 43 |
| 18 | 9237    | 572     | 973    | 396     | 706     | 189     | 436    | 953     | 161    | 686     | 42 |
| 19 | 9266    | 99570   | 11002  | 99393   | 12735   | 99186   | 14464  | 98948   | 16189  | 98681   | 41 |
| 20 | 9295    | 567     | 031    | 390     | 764     | 182     | 493    | 944     | 218    | 676     | 40 |
| 21 | 9324    | 564     | 060    | 386     | 793     | 178     | 522    | 940     | 246    | 671     | 39 |
| 22 | 9353    | 562     | 089    | 383     | 822     | 175     | 551    | 936     | 275    | 667     | 38 |
| 23 | 9382    | 559     | 118    | 380     | 851     | 171     | 580    | 931     | 304    | 662     | 37 |
| 24 | 9411    | 556     | 147    | 377     | 880     | 167     | 608    | 927     | 333    | 657     | 36 |
| 25 | 9440    | 99553   | 11176  | 99374   | 12908   | 99163   | 14637  | 98923   | 16361  | 98652   | 35 |
| 26 | 9469    | 551     | 205    | 370     | 937     | 160     | 666    | 919     | 390    | 648     | 34 |
| 27 | 9498    | 548     | 234    | 367     | 966     | 156     | 695    | 914     | 419    | 643     | 33 |
| 28 | 9527    | 545     | 263    | 364     | 995     | 152     | 723    | 910     | 447    | 638     | 32 |
| 29 | 9556    | 542     | 291    | 360     | 13024   | 148     | 752    | 906     | 476    | 633     | 31 |
| 30 | 9585    | 540     | 320    | 357     | 053     | 144     | 781    | 902     | 505    | 629     | 30 |
| 31 | 9614    | 99537   | 11349  | 99354   | 13081   | 99141   | 14810  | 98897   | 16533  | 98624   | 29 |
| 32 | 9642    | 534     | 378    | 351     | 110     | 137     | 838    | 893     | 562    | 619     | 28 |
| 33 | 9671    | 531     | 407    | 347     | 139     | 133     | 867    | 889     | 591    | 614     | 27 |
| 34 | 9700    | 528     | 436    | 344     | 168     | 129     | 896    | 884     | 620    | 609     | 26 |
| 35 | 9729    | 526     | 465    | 341     | 197     | 125     | 925    | 880     | 648    | 604     | 25 |
| 36 | 9758    | 523     | 494    | 337     | 226     | 122     | 954    | 876     | 677    | 600     | 24 |
| 37 | 9787    | 99520   | 11523  | 99334   | 13254   | 99118   | 14982  | 98871   | 16706  | 98595   | 23 |
| 38 | 9816    | 517     | 552    | 331     | 283     | 114     | 15011  | 867     | 734    | 590     | 22 |
| 39 | 9845    | 514     | 580    | 327     | 312     | 110     | 040    | 863     | 763    | 585     | 21 |
| 40 | 9874    | 511     | 609    | 324     | 341     | 106     | 069    | 858     | 792    | 580     | 20 |
| 41 | 9903    | 508     | 638    | 320     | 370     | 102     | 097    | 854     | 820    | 575     | 19 |
| 42 | 9932    | 506     | 667    | 317     | 399     | 098     | 126    | 849     | 849    | 570     | 18 |
| 43 | 9961    | 99503   | 11696  | 99314   | 13427   | 99094   | 15155  | 98845   | 16878  | 98565   | 17 |
| 44 | 9990    | 500     | 725    | 310     | 456     | 091     | 184    | 841     | 906    | 561     | 16 |
| 45 | 10019   | 497     | 754    | 307     | 485     | 087     | 212    | 836     | 935    | 556     | 15 |
| 46 | 10048   | 494     | 783    | 303     | 514     | 083     | 241    | 832     | 964    | 551     | 14 |
| 47 | 10077   | 491     | 812    | 300     | 543     | 079     | 270    | 827     | 992    | 546     | 13 |
| 48 | 10106   | 488     | 840    | 297     | 572     | 075     | 299    | 823     | 17021  | 541     | 12 |
| 49 | 10135   | 99485   | 11869  | 99293   | 13600   | 99071   | 15327  | 98818   | 17050  | 98536   | 11 |
| 50 | 164     | 482     | 898    | 290     | 629     | 067     | 356    | 814     | 078    | 531     | 10 |
| 51 | 192     | 479     | 927    | 286     | 658     | 063     | 385    | 809     | 107    | 526     | 9  |
| 52 | 221     | 476     | 956    | 283     | 687     | 059     | 414    | 805     | 136    | 521     | 8  |
| 53 | 250     | 473     | 985    | 279     | 716     | 055     | 442    | 800     | 164    | 516     | 7  |
| 54 | 279     | 470     | 12014  | 276     | 744     | 051     | 471    | 796     | 193    | 511     | 6  |
| 55 | 10308   | 99467   | 12043  | 99272   | 13773   | 99047   | 15500  | 98791   | 17222  | 98506   | 5  |
| 56 | 337     | 464     | 071    | 269     | 802     | 043     | 529    | 787     | 250    | 501     | 4  |
| 57 | 366     | 461     | 100    | 265     | 831     | 039     | 557    | 782     | 279    | 496     | 3  |
| 58 | 395     | 458     | 129    | 262     | 860     | 035     | 586    | 778     | 308    | 491     | 2  |
| 59 | 424     | 455     | 158    | 258     | 889     | 031     | 615    | 773     | 336    | 486     | 1  |
| M. | N. col. | N. fine | N.col. | N. fine | N. col. | N. fine | N.col. | N. fine | N.col. | N. fine | M. |
|    | 84°     |         | 83°    |         | 82°     |         | 81°    |         | 80°    |         |    |



TABLE VIII. OF NATURAL SINES.

|    | 10°    |        | 11°    |        | 12°    |        | 13°    |        | 14°    |        |    |
|----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|----|
| M. | N fine | N col. | N fine | N col. | N fine | N col. | N fine | N col. | N fine | N col. | M. |
| 0  | 17365  | 98481  | 19081  | 98163  | 20791  | 97815  | 22495  | 97437  | 24192  | 97030  | 60 |
| 1  | 393    | 476    | 109    | 157    | 820    | 809    | 523    | 430    | 220    | 023    | 59 |
| 2  | 422    | 471    | 138    | 152    | 848    | 803    | 552    | 424    | 249    | 015    | 58 |
| 3  | 451    | 466    | 167    | 146    | 877    | 797    | 580    | 417    | 277    | 008    | 57 |
| 4  | 479    | 461    | 195    | 140    | 905    | 791    | 608    | 411    | 305    | 001    | 56 |
| 5  | 508    | 455    | 224    | 135    | 933    | 784    | 637    | 404    | 333    | 96994  | 55 |
| 6  | 537    | 450    | 252    | 129    | 962    | 778    | 665    | 398    | 362    | 987    | 54 |
| 7  | 17565  | 98445  | 19281  | 98124  | 20990  | 97772  | 22693  | 97391  | 24390  | 96980  | 53 |
| 8  | 594    | 440    | 309    | 118    | 21019  | 766    | 722    | 384    | 418    | 973    | 52 |
| 9  | 623    | 435    | 338    | 112    | 047    | 760    | 750    | 378    | 446    | 966    | 51 |
| 10 | 651    | 430    | 366    | 107    | 076    | 754    | 778    | 371    | 474    | 959    | 50 |
| 11 | 680    | 425    | 395    | 101    | 104    | 748    | 807    | 365    | 503    | 952    | 49 |
| 12 | 708    | 420    | 423    | 096    | 132    | 742    | 835    | 358    | 531    | 945    | 48 |
| 13 | 17737  | 98414  | 19452  | 98090  | 21161  | 97735  | 22863  | 97351  | 24559  | 96937  | 47 |
| 14 | 766    | 409    | 481    | 084    | 189    | 729    | 892    | 345    | 587    | 930    | 46 |
| 15 | 794    | 404    | 509    | 079    | 218    | 723    | 920    | 338    | 615    | 923    | 45 |
| 16 | 823    | 399    | 538    | 073    | 246    | 717    | 948    | 331    | 644    | 916    | 44 |
| 17 | 852    | 394    | 566    | 067    | 275    | 711    | 977    | 325    | 672    | 909    | 43 |
| 18 | 880    | 389    | 595    | 061    | 303    | 705    | 23005  | 318    | 700    | 902    | 42 |
| 19 | 17909  | 98383  | 19623  | 98056  | 21331  | 97698  | 23033  | 97311  | 24728  | 96894  | 41 |
| 20 | 937    | 378    | 652    | 050    | 360    | 692    | 062    | 304    | 756    | 887    | 40 |
| 21 | 966    | 373    | 680    | 044    | 388    | 686    | 090    | 298    | 784    | 880    | 39 |
| 22 | 995    | 368    | 709    | 039    | 417    | 680    | 118    | 291    | 813    | 873    | 38 |
| 23 | 18023  | 362    | 737    | 033    | 445    | 673    | 146    | 284    | 841    | 866    | 37 |
| 24 | 052    | 357    | 766    | 027    | 474    | 667    | 175    | 278    | 869    | 858    | 36 |
| 25 | 18081  | 98352  | 19794  | 98021  | 21502  | 97661  | 23203  | 97271  | 24897  | 96851  | 35 |
| 26 | 109    | 347    | 823    | 016    | 530    | 655    | 231    | 264    | 925    | 844    | 34 |
| 27 | 138    | 341    | 851    | 010    | 559    | 648    | 260    | 257    | 953    | 837    | 33 |
| 28 | 166    | 336    | 880    | 004    | 587    | 642    | 288    | 251    | 982    | 829    | 32 |
| 29 | 195    | 331    | 908    | 97998  | 616    | 636    | 316    | 244    | 25010  | 822    | 31 |
| 30 | 224    | 325    | 937    | 992    | 644    | 630    | 345    | 237    | 038    | 815    | 30 |
| 31 | 18252  | 98320  | 19965  | 97987  | 21672  | 97623  | 23373  | 97230  | 25066  | 96807  | 29 |
| 32 | 281    | 315    | 994    | 981    | 701    | 617    | 401    | 223    | 094    | 800    | 28 |
| 33 | 309    | 310    | 20022  | 975    | 729    | 611    | 429    | 217    | 122    | 793    | 27 |
| 34 | 338    | 304    | 051    | 969    | 758    | 604    | 458    | 210    | 151    | 786    | 26 |
| 35 | 367    | 299    | 079    | 963    | 786    | 598    | 486    | 203    | 179    | 778    | 25 |
| 36 | 395    | 294    | 108    | 958    | 814    | 592    | 514    | 196    | 207    | 771    | 24 |
| 37 | 18424  | 98288  | 20136  | 97952  | 21843  | 97585  | 23542  | 97189  | 25235  | 96764  | 23 |
| 38 | 452    | 283    | 165    | 946    | 871    | 579    | 571    | 182    | 263    | 756    | 22 |
| 39 | 481    | 277    | 193    | 940    | 899    | 573    | 599    | 176    | 291    | 749    | 21 |
| 40 | 509    | 272    | 222    | 934    | 928    | 566    | 627    | 169    | 320    | 742    | 20 |
| 41 | 538    | 267    | 250    | 928    | 956    | 560    | 656    | 162    | 348    | 734    | 19 |
| 42 | 567    | 261    | 279    | 922    | 985    | 553    | 684    | 155    | 376    | 727    | 18 |
| 43 | 18595  | 98256  | 20307  | 97916  | 22013  | 97547  | 23712  | 97148  | 25404  | 96719  | 17 |
| 44 | 624    | 250    | 336    | 910    | 041    | 541    | 740    | 141    | 432    | 712    | 16 |
| 45 | 652    | 245    | 364    | 905    | 070    | 534    | 769    | 134    | 460    | 705    | 15 |
| 46 | 681    | 240    | 393    | 899    | 098    | 528    | 797    | 127    | 488    | 697    | 14 |
| 47 | 710    | 234    | 421    | 893    | 126    | 521    | 825    | 120    | 516    | 690    | 13 |
| 48 | 738    | 229    | 450    | 887    | 155    | 515    | 853    | 113    | 545    | 682    | 12 |
| 49 | 18767  | 98223  | 20478  | 97881  | 22183  | 97508  | 23882  | 97106  | 25573  | 96675  | 11 |
| 50 | 795    | 218    | 507    | 875    | 212    | 502    | 910    | 100    | 601    | 667    | 10 |
| 51 | 824    | 212    | 535    | 869    | 240    | 496    | 938    | 093    | 629    | 660    | 9  |
| 52 | 852    | 207    | 563    | 863    | 268    | 489    | 966    | 086    | 657    | 653    | 8  |
| 53 | 881    | 201    | 592    | 857    | 297    | 483    | 995    | 079    | 685    | 645    | 7  |
| 54 | 910    | 196    | 620    | 851    | 325    | 476    | 24023  | 072    | 713    | 638    | 6  |
| 55 | 18938  | 98190  | 20649  | 97845  | 22353  | 97470  | 24051  | 97065  | 25741  | 96630  | 5  |
| 56 | 967    | 185    | 677    | 839    | 382    | 463    | 079    | 058    | 769    | 623    | 4  |
| 57 | 995    | 179    | 706    | 833    | 410    | 457    | 108    | 051    | 798    | 615    | 3  |
| 58 | 19024  | 174    | 734    | 827    | 438    | 450    | 136    | 044    | 826    | 608    | 2  |
| 59 | 052    | 168    | 763    | 821    | 467    | 444    | 164    | 037    | 854    | 600    | 1  |
| M. | N col. | N fine | N col. | N fine | N col. | N fine | N col. | N fine | N col. | N fine | M. |
|    | 79°    |        | 78°    |        | 77°    |        | 76°    |        | 75°    |        |    |

TABLE VIII. OF NATURAL SINES.

|    | 15°    | 16°    | 17°    | 18°    | 19°    |        |        |        |        |        |    |
|----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|----|
| M. | N.fine | N.co   | N.fine | N.co   | N.fine | N.co   | N.fine | N.co   | N.fine | N.co   | M. |
| 0  | 25882  | 96593  | 27564  | 96126  | 29237  | 95630  | 30902  | 95106  | 32557  | 94552  | 60 |
| 1  | 910    | 585    | 592    | 118    | 265    | 622    | 929    | 097    | 584    | 542    | 59 |
| 2  | 938    | 578    | 620    | 110    | 293    | 613    | 957    | 088    | 612    | 533    | 58 |
| 3  | 966    | 570    | 648    | 102    | 321    | 605    | 985    | 079    | 639    | 523    | 57 |
| 4  | 994    | 562    | 676    | 094    | 348    | 596    | 31012  | 070    | 667    | 514    | 56 |
| 5  | 26022  | 555    | 704    | 086    | 376    | 588    | 040    | 061    | 694    | 504    | 55 |
| 6  | 050    | 547    | 731    | 078    | 404    | 579    | 068    | 052    | 722    | 495    | 54 |
| 7  | 26079  | 96540  | 27759  | 96070  | 29432  | 95571  | 31095  | 95043  | 32749  | 94485  | 53 |
| 8  | 107    | 532    | 787    | 062    | 460    | 562    | 123    | 033    | 777    | 476    | 52 |
| 9  | 135    | 524    | 815    | 054    | 487    | 554    | 151    | 024    | 804    | 466    | 51 |
| 10 | 163    | 517    | 843    | 046    | 515    | 545    | 178    | 015    | 832    | 457    | 50 |
| 11 | 191    | 509    | 871    | 037    | 543    | 536    | 206    | 006    | 859    | 447    | 49 |
| 12 | 219    | 502    | 899    | 029    | 571    | 528    | 233    | 94997  | 887    | 438    | 48 |
| 13 | 26247  | 96494  | 27927  | 96021  | 29599  | 95519  | 31261  | 94988  | 32914  | 94428  | 47 |
| 14 | 275    | 486    | 955    | 013    | 626    | 511    | 289    | 979    | 942    | 418    | 46 |
| 15 | 303    | 479    | 983    | 005    | 654    | 502    | 316    | 970    | 969    | 409    | 45 |
| 16 | 331    | 471    | 28011  | 95997  | 682    | 493    | 344    | 961    | 997    | 399    | 44 |
| 17 | 359    | 463    | 039    | 989    | 710    | 485    | 372    | 952    | 33024  | 390    | 43 |
| 18 | 387    | 456    | 067    | 981    | 737    | 476    | 399    | 943    | 051    | 380    | 42 |
| 19 | 26415  | 96448  | 28095  | 95972  | 29765  | 95467  | 31427  | 94933  | 33079  | 94370  | 41 |
| 20 | 443    | 440    | 123    | 964    | 793    | 459    | 454    | 924    | 106    | 361    | 40 |
| 21 | 471    | 433    | 150    | 956    | 821    | 450    | 482    | 915    | 134    | 351    | 39 |
| 22 | 500    | 425    | 178    | 948    | 849    | 441    | 510    | 906    | 161    | 342    | 38 |
| 23 | 528    | 417    | 206    | 940    | 876    | 433    | 537    | 897    | 189    | 332    | 37 |
| 24 | 556    | 410    | 234    | 931    | 904    | 424    | 565    | 888    | 216    | 322    | 36 |
| 25 | 26584  | 96402  | 28262  | 95923  | 29932  | 95415  | 31593  | 94878  | 33244  | 94313  | 35 |
| 26 | 612    | 394    | 290    | 915    | 960    | 407    | 620    | 869    | 271    | 303    | 34 |
| 27 | 640    | 386    | 318    | 907    | 987    | 398    | 648    | 860    | 298    | 293    | 33 |
| 28 | 668    | 379    | 346    | 898    | 30015  | 389    | 675    | 851    | 326    | 284    | 32 |
| 29 | 696    | 371    | 374    | 890    | 043    | 380    | 703    | 842    | 353    | 274    | 31 |
| 30 | 724    | 363    | 402    | 882    | 071    | 372    | 730    | 832    | 381    | 264    | 30 |
| 31 | 26752  | 96355  | 28429  | 95874  | 30098  | 95363  | 31758  | 94823  | 33408  | 94254  | 29 |
| 32 | 780    | 347    | 457    | 865    | 126    | 354    | 786    | 814    | 436    | 245    | 28 |
| 33 | 808    | 340    | 485    | 857    | 154    | 345    | 813    | 805    | 463    | 235    | 27 |
| 34 | 836    | 332    | 513    | 849    | 182    | 337    | 841    | 795    | 490    | 225    | 26 |
| 35 | 864    | 324    | 541    | 841    | 209    | 328    | 868    | 786    | 518    | 215    | 25 |
| 36 | 892    | 316    | 569    | 832    | 237    | 319    | 896    | 777    | 545    | 206    | 24 |
| 37 | 26920  | 96308  | 28597  | 95824  | 30265  | 95310  | 31923  | 94768  | 33573  | 94196  | 23 |
| 38 | 948    | 301    | 625    | 816    | 292    | 301    | 951    | 758    | 600    | 186    | 22 |
| 39 | 976    | 293    | 652    | 807    | 320    | 293    | 979    | 749    | 627    | 176    | 21 |
| 40 | 27004  | 285    | 680    | 799    | 348    | 284    | 32006  | 740    | 655    | 167    | 20 |
| 41 | 032    | 277    | 708    | 791    | 376    | 275    | 034    | 730    | 682    | 157    | 19 |
| 42 | 060    | 269    | 736    | 782    | 403    | 266    | 061    | 721    | 710    | 147    | 18 |
| 43 | 27088  | 96261  | 28764  | 95774  | 30431  | 95257  | 32089  | 94712  | 33737  | 94137  | 17 |
| 44 | 116    | 253    | 792    | 766    | 459    | 248    | 116    | 702    | 764    | 127    | 16 |
| 45 | 144    | 246    | 820    | 757    | 486    | 240    | 144    | 693    | 792    | 118    | 15 |
| 46 | 172    | 238    | 847    | 749    | 514    | 231    | 171    | 684    | 819    | 108    | 14 |
| 47 | 200    | 230    | 875    | 740    | 542    | 222    | 199    | 674    | 846    | 098    | 13 |
| 48 | 228    | 222    | 903    | 732    | 570    | 213    | 227    | 665    | 874    | 088    | 12 |
| 49 | 27256  | 96214  | 28931  | 95724  | 30597  | 95204  | 32254  | 94656  | 33901  | 94078  | 11 |
| 50 | 284    | 206    | 959    | 715    | 625    | 195    | 282    | 646    | 929    | 068    | 10 |
| 51 | 312    | 198    | 987    | 707    | 653    | 186    | 309    | 637    | 956    | 058    | 9  |
| 52 | 340    | 190    | 29015  | 698    | 680    | 177    | 337    | 627    | 983    | 049    | 8  |
| 53 | 368    | 182    | 042    | 690    | 708    | 168    | 364    | 618    | 34011  | 039    | 7  |
| 54 | 396    | 174    | 070    | 681    | 736    | 159    | 392    | 609    | 038    | 029    | 6  |
| 55 | 27424  | 96166  | 29098  | 95673  | 30763  | 95150  | 32419  | 94599  | 34065  | 94019  | 5  |
| 56 | 452    | 158    | 126    | 664    | 791    | 142    | 447    | 590    | 093    | 009    | 4  |
| 57 | 480    | 150    | 154    | 656    | 819    | 133    | 474    | 580    | 120    | 93999  | 3  |
| 58 | 508    | 142    | 182    | 647    | 846    | 124    | 502    | 571    | 147    | 989    | 2  |
| 59 | 536    | 134    | 209    | 639    | 874    | 115    | 529    | 561    | 175    | 979    | 1  |
| M. | N.co   | N.fine | N.co   | N.fine | N.co   | N.fine | N.co   | N.fine | N.co   | N.fine | M. |
|    | 74°    |        | 73°    |        | 72°    |        | 71°    |        | 70°    |        |    |

TABLE VIII. OF NATURAL SINES.

| 20° |         | 21°     |         | 22°     |         | 23°     |         | 24°     |         |         |    |
|-----|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----|
| M.  | N. fine | N. col. | N. fine | N. col. | N. fine | N. col. | N. fine | N. col. | N. fine | N. col. | M. |
| 0   | 34202   | 93969   | 35837   | 93358   | 37461   | 92718   | 39073   | 92050   | 40674   | 91355   | 60 |
| 1   | 229     | 959     | 864     | 348     | 488     | 707     | 100     | 039     | 700     | 343     | 59 |
| 2   | 257     | 949     | 891     | 337     | 515     | 697     | 127     | 028     | 727     | 331     | 58 |
| 3   | 284     | 939     | 918     | 327     | 542     | 686     | 153     | 016     | 753     | 319     | 57 |
| 4   | 311     | 929     | 945     | 316     | 569     | 675     | 180     | 005     | 780     | 307     | 56 |
| 5   | 339     | 919     | 973     | 306     | 595     | 664     | 207     | 91994   | 806     | 295     | 55 |
| 6   | 366     | 909     | 36000   | 295     | 622     | 653     | 234     | 982     | 833     | 283     | 54 |
| 7   | 34393   | 93899   | 36027   | 93285   | 37649   | 92642   | 39260   | 91971   | 40860   | 91272   | 53 |
| 8   | 421     | 889     | 054     | 274     | 676     | 631     | 287     | 959     | 886     | 260     | 52 |
| 9   | 448     | 879     | 081     | 264     | 703     | 620     | 314     | 948     | 913     | 248     | 51 |
| 10  | 475     | 869     | 108     | 253     | 730     | 609     | 341     | 936     | 939     | 236     | 50 |
| 11  | 503     | 859     | 135     | 243     | 757     | 598     | 367     | 925     | 966     | 224     | 49 |
| 12  | 530     | 849     | 162     | 232     | 784     | 587     | 394     | 914     | 992     | 212     | 48 |
| 13  | 34557   | 93839   | 36190   | 93222   | 37811   | 92576   | 39421   | 91902   | 41019   | 91200   | 47 |
| 14  | 584     | 829     | 217     | 211     | 838     | 565     | 448     | 891     | 045     | 188     | 46 |
| 15  | 612     | 819     | 244     | 201     | 865     | 554     | 474     | 879     | 072     | 176     | 45 |
| 16  | 639     | 809     | 271     | 190     | 892     | 543     | 501     | 868     | 098     | 164     | 44 |
| 17  | 666     | 799     | 298     | 180     | 919     | 532     | 528     | 856     | 125     | 152     | 43 |
| 18  | 694     | 789     | 325     | 169     | 946     | 521     | 555     | 845     | 151     | 140     | 42 |
| 19  | 34721   | 93779   | 36352   | 93159   | 37973   | 92510   | 39581   | 91833   | 41178   | 91128   | 41 |
| 20  | 748     | 769     | 379     | 148     | 999     | 499     | 608     | 822     | 204     | 116     | 40 |
| 21  | 775     | 759     | 406     | 137     | 38026   | 488     | 635     | 810     | 231     | 104     | 39 |
| 22  | 803     | 748     | 434     | 127     | 053     | 477     | 661     | 799     | 257     | 092     | 38 |
| 23  | 830     | 738     | 461     | 116     | 080     | 466     | 688     | 787     | 284     | 080     | 37 |
| 24  | 857     | 728     | 488     | 106     | 107     | 455     | 715     | 775     | 310     | 068     | 36 |
| 25  | 34884   | 93718   | 36515   | 93095   | 38134   | 92444   | 39741   | 91764   | 41337   | 91056   | 35 |
| 26  | 912     | 708     | 542     | 084     | 161     | 432     | 768     | 752     | 363     | 044     | 34 |
| 27  | 939     | 698     | 569     | 074     | 188     | 421     | 795     | 741     | 390     | 032     | 33 |
| 28  | 966     | 688     | 596     | 063     | 215     | 410     | 822     | 729     | 416     | 020     | 32 |
| 29  | 993     | 677     | 623     | 052     | 241     | 399     | 848     | 718     | 443     | 008     | 31 |
| 30  | 35021   | 667     | 650     | 042     | 268     | 388     | 875     | 706     | 469     | 90996   | 30 |
| 31  | 35048   | 93657   | 36677   | 93031   | 38295   | 92377   | 39902   | 91694   | 41496   | 90984   | 29 |
| 32  | 075     | 647     | 704     | 020     | 322     | 366     | 928     | 683     | 522     | 972     | 28 |
| 33  | 102     | 637     | 731     | 010     | 349     | 355     | 955     | 671     | 549     | 960     | 27 |
| 34  | 130     | 626     | 758     | 92999   | 376     | 343     | 982     | 660     | 575     | 948     | 26 |
| 35  | 157     | 616     | 785     | 988     | 403     | 332     | 40008   | 648     | 602     | 936     | 25 |
| 36  | 184     | 606     | 812     | 978     | 430     | 321     | 035     | 636     | 628     | 924     | 24 |
| 37  | 35211   | 93596   | 36839   | 92967   | 38456   | 92310   | 40062   | 91625   | 41655   | 90911   | 23 |
| 38  | 239     | 585     | 867     | 956     | 483     | 299     | 088     | 613     | 681     | 899     | 22 |
| 39  | 266     | 575     | 894     | 945     | 510     | 287     | 115     | 601     | 707     | 887     | 21 |
| 40  | 293     | 565     | 921     | 935     | 537     | 276     | 141     | 590     | 734     | 875     | 20 |
| 41  | 320     | 555     | 948     | 924     | 564     | 265     | 168     | 578     | 760     | 863     | 19 |
| 42  | 347     | 544     | 975     | 913     | 591     | 254     | 195     | 566     | 787     | 851     | 18 |
| 43  | 35375   | 93534   | 37002   | 92902   | 38617   | 92243   | 40221   | 91555   | 41813   | 90839   | 17 |
| 44  | 402     | 524     | 029     | 892     | 644     | 231     | 248     | 543     | 840     | 826     | 16 |
| 45  | 429     | 514     | 056     | 881     | 671     | 220     | 275     | 531     | 866     | 814     | 15 |
| 46  | 456     | 503     | 083     | 870     | 698     | 209     | 301     | 519     | 892     | 802     | 14 |
| 47  | 484     | 493     | 110     | 859     | 725     | 198     | 328     | 508     | 919     | 790     | 13 |
| 48  | 511     | 483     | 137     | 849     | 752     | 186     | 355     | 496     | 945     | 778     | 12 |
| 49  | 35538   | 93472   | 37164   | 92838   | 38778   | 92175   | 40381   | 91484   | 41972   | 90766   | 11 |
| 50  | 565     | 462     | 191     | 827     | 805     | 164     | 408     | 472     | 998     | 753     | 10 |
| 51  | 592     | 452     | 218     | 816     | 832     | 152     | 434     | 461     | 42024   | 741     | 9  |
| 52  | 619     | 441     | 245     | 805     | 859     | 141     | 461     | 449     | 051     | 729     | 8  |
| 53  | 647     | 431     | 272     | 794     | 886     | 130     | 488     | 437     | 077     | 717     | 7  |
| 54  | 674     | 420     | 299     | 784     | 912     | 119     | 514     | 425     | 104     | 704     | 6  |
| 55  | 35701   | 93410   | 37326   | 92773   | 38939   | 92107   | 40541   | 91414   | 42130   | 90692   | 5  |
| 56  | 728     | 400     | 353     | 762     | 966     | 096     | 567     | 402     | 156     | 680     | 4  |
| 57  | 755     | 389     | 380     | 751     | 993     | 085     | 594     | 390     | 183     | 668     | 3  |
| 58  | 782     | 379     | 407     | 740     | 39020   | 073     | 621     | 378     | 209     | 655     | 2  |
| 59  | 810     | 368     | 434     | 729     | 046     | 062     | 647     | 366     | 235     | 643     | 1  |
| M.  | N. col. | N. fine | N. col. | N. fine | N. col. | N. fine | N. col. | N. fine | N. col. | N. fine | M. |
| 69° |         | 68°     |         | 67°     |         | 66°     |         | 65°     |         |         |    |



TABLE VIII. OF NATURAL SINES.

| M. | 25°     |         | 26°     |         | 27°     |         | 28°     |         | 29°     |         | M. |
|----|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----|
|    | N. fine | N. col  | N. fine | N. col  | N. fine | N. col  | N. fine | N. col  | N. fine | N. col  |    |
| 0  | 42262   | 90631   | 43837   | 89879   | 45399   | 89101   | 46947   | 88295   | 48481   | 87462   | 60 |
| 1  | 288     | 618     | 863     | 867     | 425     | 087     | 973     | 281     | 506     | 448     | 59 |
| 2  | 315     | 606     | 889     | 854     | 451     | 074     | 999     | 267     | 532     | 434     | 58 |
| 3  | 341     | 594     | 916     | 841     | 477     | 061     | 47024   | 254     | 557     | 420     | 57 |
| 4  | 367     | 582     | 942     | 828     | 503     | 048     | 050     | 240     | 583     | 406     | 56 |
| 5  | 394     | 569     | 968     | 816     | 529     | 035     | 076     | 226     | 608     | 391     | 55 |
| 6  | 420     | 557     | 994     | 803     | 554     | 021     | 101     | 213     | 634     | 377     | 54 |
| 7  | 42446   | 90545   | 44020   | 89790   | 45580   | 89008   | 47127   | 88199   | 48659   | 87363   | 53 |
| 8  | 473     | 532     | 046     | 777     | 606     | 88995   | 153     | 185     | 684     | 349     | 52 |
| 9  | 499     | 520     | 072     | 764     | 632     | 981     | 178     | 172     | 710     | 335     | 51 |
| 10 | 525     | 507     | 098     | 752     | 658     | 968     | 204     | 158     | 735     | 321     | 50 |
| 11 | 552     | 495     | 124     | 739     | 684     | 955     | 229     | 144     | 761     | 306     | 49 |
| 12 | 578     | 483     | 151     | 726     | 710     | 942     | 255     | 130     | 786     | 292     | 48 |
| 13 | 42604   | 90470   | 44177   | 89713   | 45736   | 88928   | 47281   | 88117   | 48811   | 87278   | 47 |
| 14 | 631     | 458     | 203     | 700     | 762     | 915     | 306     | 103     | 837     | 264     | 46 |
| 15 | 657     | 446     | 229     | 687     | 787     | 902     | 332     | 089     | 862     | 250     | 45 |
| 16 | 683     | 433     | 255     | 674     | 813     | 888     | 358     | 075     | 888     | 235     | 44 |
| 17 | 709     | 421     | 281     | 662     | 839     | 875     | 383     | 062     | 913     | 221     | 43 |
| 18 | 736     | 408     | 307     | 649     | 865     | 862     | 409     | 048     | 938     | 207     | 42 |
| 19 | 42762   | 90396   | 44333   | 89636   | 45891   | 88848   | 47434   | 88034   | 48964   | 87193   | 41 |
| 20 | 788     | 383     | 359     | 623     | 917     | 835     | 460     | 020     | 989     | 178     | 40 |
| 21 | 815     | 371     | 385     | 610     | 942     | 822     | 486     | 006     | 49014   | 164     | 39 |
| 22 | 841     | 358     | 411     | 597     | 968     | 808     | 511     | 87993   | 040     | 150     | 38 |
| 23 | 867     | 346     | 437     | 584     | 994     | 795     | 537     | 979     | 065     | 136     | 37 |
| 24 | 894     | 334     | 464     | 571     | 46020   | 782     | 562     | 965     | 090     | 121     | 36 |
| 25 | 42920   | 90321   | 44490   | 89558   | 46046   | 88768   | 47588   | 87951   | 49116   | 87107   | 35 |
| 26 | 946     | 309     | 516     | 545     | 072     | 755     | 614     | 937     | 141     | 093     | 34 |
| 27 | 972     | 296     | 542     | 532     | 097     | 741     | 639     | 923     | 166     | 079     | 33 |
| 28 | 999     | 284     | 568     | 519     | 123     | 728     | 665     | 909     | 192     | 064     | 32 |
| 29 | 43025   | 271     | 594     | 506     | 149     | 715     | 690     | 896     | 217     | 050     | 31 |
| 30 | 051     | 259     | 620     | 493     | 175     | 701     | 716     | 882     | 242     | 036     | 30 |
| 31 | 43077   | 90246   | 44646   | 89480   | 46201   | 88688   | 47741   | 87868   | 49268   | 87021   | 29 |
| 32 | 104     | 233     | 672     | 467     | 226     | 674     | 767     | 854     | 293     | 007     | 28 |
| 33 | 130     | 221     | 698     | 454     | 252     | 661     | 793     | 840     | 318     | 86993   | 27 |
| 34 | 156     | 208     | 724     | 441     | 278     | 647     | 818     | 826     | 344     | 978     | 26 |
| 35 | 182     | 196     | 750     | 428     | 304     | 634     | 844     | 812     | 369     | 964     | 25 |
| 36 | 209     | 183     | 776     | 415     | 330     | 620     | 869     | 798     | 394     | 949     | 24 |
| 37 | 43235   | 90171   | 44802   | 89402   | 46355   | 88607   | 47895   | 87784   | 49419   | 86935   | 23 |
| 38 | 261     | 158     | 828     | 389     | 381     | 593     | 920     | 770     | 445     | 921     | 22 |
| 39 | 287     | 146     | 854     | 376     | 407     | 580     | 946     | 756     | 470     | 906     | 21 |
| 40 | 313     | 133     | 880     | 363     | 433     | 566     | 972     | 743     | 495     | 892     | 20 |
| 41 | 340     | 120     | 906     | 350     | 458     | 553     | 997     | 729     | 521     | 878     | 19 |
| 42 | 366     | 108     | 932     | 337     | 484     | 539     | 48022   | 715     | 546     | 863     | 18 |
| 43 | 43392   | 90095   | 44958   | 89324   | 46510   | 88526   | 48048   | 87701   | 49571   | 86849   | 17 |
| 44 | 418     | 082     | 984     | 311     | 536     | 512     | 073     | 687     | 596     | 834     | 16 |
| 45 | 445     | 070     | 45010   | 298     | 561     | 499     | 099     | 673     | 622     | 820     | 15 |
| 46 | 471     | 057     | 036     | 285     | 587     | 485     | 124     | 659     | 647     | 805     | 14 |
| 47 | 497     | 045     | 062     | 272     | 613     | 472     | 150     | 645     | 672     | 791     | 13 |
| 48 | 523     | 032     | 088     | 259     | 639     | 458     | 175     | 631     | 697     | 777     | 12 |
| 49 | 43549   | 90019   | 45114   | 89245   | 46664   | 88445   | 48201   | 87617   | 49723   | 86762   | 11 |
| 50 | 575     | 007     | 140     | 232     | 690     | 431     | 226     | 603     | 748     | 748     | 10 |
| 51 | 602     | 89994   | 166     | 219     | 716     | 417     | 252     | 589     | 773     | 733     | 9  |
| 52 | 628     | 981     | 192     | 206     | 742     | 404     | 277     | 575     | 798     | 719     | 8  |
| 53 | 654     | 968     | 218     | 193     | 767     | 390     | 303     | 561     | 824     | 704     | 7  |
| 54 | 680     | 956     | 243     | 180     | 793     | 377     | 328     | 546     | 849     | 690     | 6  |
| 55 | 43706   | 89943   | 45269   | 89167   | 46819   | 88363   | 48354   | 87532   | 49874   | 86675   | 5  |
| 56 | 732     | 930     | 295     | 153     | 844     | 349     | 379     | 518     | 899     | 661     | 4  |
| 57 | 759     | 918     | 321     | 140     | 870     | 336     | 405     | 504     | 924     | 646     | 3  |
| 58 | 785     | 905     | 347     | 127     | 896     | 322     | 430     | 490     | 950     | 632     | 2  |
| 59 | 811     | 892     | 373     | 114     | 921     | 308     | 456     | 476     | 975     | 617     | 1  |
| M. | N. col  | N. fine | N. col  | N. fine | N. col  | N. fine | N. col  | N. fine | N. col  | N. fine | M. |
|    | 64°     |         | 63°     |         | 62°     |         | 61°     |         | 60°     |         |    |

TABLE VIII. OF NATURAL SINES.

|    | 30°     |        | 31°     |         | 32°     |         | 33°     |         | 34°     |         |    |
|----|---------|--------|---------|---------|---------|---------|---------|---------|---------|---------|----|
| M. | N fine  | N. col | N fine  | N. col. | N fine  | N. col. | N fine  | N. col. | N fine  | N. col. | M. |
| 0  | 50000   | 86603  | 51504   | 85717   | 52992   | 84805   | 54464   | 83867   | 55919   | 82904   | 60 |
| 1  | 025     | 588    | 529     | 702     | 53017   | 789     | 488     | 851     | 943     | 887     | 59 |
| 2  | 050     | 573    | 554     | 687     | 041     | 774     | 513     | 835     | 968     | 871     | 58 |
| 3  | 076     | 559    | 579     | 672     | 066     | 759     | 537     | 819     | 992     | 855     | 57 |
| 4  | 101     | 544    | 604     | 657     | 091     | 743     | 561     | 804     | 56016   | 839     | 56 |
| 5  | 126     | 530    | 628     | 642     | 115     | 728     | 586     | 788     | 040     | 822     | 55 |
| 6  | 151     | 515    | 653     | 627     | 140     | 712     | 610     | 772     | 064     | 806     | 54 |
| 7  | 50176   | 86501  | 51678   | 85612   | 53164   | 84697   | 54635   | 83756   | 56088   | 82790   | 53 |
| 8  | 201     | 486    | 703     | 597     | 189     | 681     | 659     | 740     | 112     | 773     | 52 |
| 9  | 227     | 471    | 728     | 582     | 214     | 666     | 683     | 724     | 136     | 757     | 51 |
| 10 | 252     | 457    | 753     | 567     | 238     | 650     | 708     | 708     | 160     | 741     | 50 |
| 11 | 277     | 442    | 778     | 551     | 263     | 635     | 732     | 692     | 184     | 724     | 49 |
| 12 | 302     | 427    | 803     | 536     | 288     | 619     | 756     | 676     | 208     | 708     | 48 |
| 13 | 50327   | 86413  | 51828   | 85521   | 53312   | 84604   | 54781   | 83660   | 56232   | 82692   | 47 |
| 14 | 352     | 398    | 852     | 506     | 337     | 588     | 805     | 645     | 256     | 675     | 46 |
| 15 | 377     | 384    | 877     | 491     | 361     | 573     | 829     | 629     | 280     | 659     | 45 |
| 16 | 403     | 369    | 902     | 476     | 386     | 557     | 854     | 613     | 305     | 643     | 44 |
| 17 | 428     | 354    | 927     | 461     | 411     | 542     | 878     | 597     | 329     | 626     | 43 |
| 18 | 453     | 340    | 952     | 446     | 435     | 526     | 902     | 581     | 353     | 610     | 42 |
| 19 | 50478   | 86325  | 51977   | 85431   | 53460   | 84511   | 54927   | 83565   | 56377   | 82593   | 41 |
| 20 | 503     | 310    | 52002   | 416     | 484     | 495     | 951     | 549     | 401     | 577     | 40 |
| 21 | 528     | 295    | 026     | 401     | 509     | 480     | 975     | 533     | 425     | 561     | 39 |
| 22 | 553     | 281    | 051     | 385     | 534     | 464     | 999     | 517     | 449     | 544     | 38 |
| 23 | 578     | 266    | 076     | 370     | 558     | 448     | 55024   | 501     | 473     | 528     | 37 |
| 24 | 603     | 251    | 101     | 355     | 583     | 433     | 048     | 485     | 497     | 511     | 36 |
| 25 | 50628   | 86237  | 52126   | 85340   | 53607   | 84417   | 55072   | 83469   | 56521   | 82495   | 35 |
| 26 | 654     | 222    | 151     | 325     | 632     | 402     | 097     | 453     | 545     | 478     | 34 |
| 27 | 679     | 207    | 175     | 310     | 656     | 386     | 121     | 437     | 569     | 462     | 33 |
| 28 | 704     | 192    | 200     | 294     | 681     | 370     | 145     | 421     | 593     | 446     | 32 |
| 29 | 729     | 178    | 225     | 279     | 705     | 355     | 169     | 405     | 617     | 429     | 31 |
| 30 | 754     | 163    | 250     | 264     | 730     | 339     | 194     | 389     | 641     | 413     | 30 |
| 31 | 50779   | 86148  | 52275   | 85249   | 53754   | 84324   | 55218   | 83373   | 56665   | 82396   | 29 |
| 32 | 804     | 133    | 299     | 234     | 779     | 308     | 242     | 356     | 689     | 380     | 28 |
| 33 | 829     | 119    | 324     | 218     | 804     | 292     | 266     | 340     | 713     | 363     | 27 |
| 34 | 854     | 104    | 349     | 203     | 828     | 277     | 291     | 324     | 736     | 347     | 26 |
| 35 | 879     | 089    | 374     | 188     | 853     | 261     | 315     | 308     | 760     | 330     | 25 |
| 36 | 904     | 074    | 399     | 173     | 877     | 245     | 339     | 292     | 784     | 314     | 24 |
| 37 | 50929   | 86059  | 52423   | 85157   | 53902   | 84230   | 55363   | 83276   | 56808   | 82297   | 23 |
| 38 | 954     | 045    | 448     | 142     | 926     | 214     | 388     | 260     | 832     | 281     | 22 |
| 39 | 979     | 030    | 473     | 127     | 951     | 198     | 412     | 244     | 856     | 264     | 21 |
| 40 | 51004   | 015    | 498     | 112     | 975     | 182     | 436     | 228     | 880     | 248     | 20 |
| 41 | 029     | 000    | 522     | 096     | 54000   | 167     | 460     | 212     | 904     | 231     | 19 |
| 42 | 054     | 85985  | 547     | 081     | 024     | 151     | 484     | 195     | 928     | 214     | 18 |
| 43 | 51079   | 85970  | 52572   | 85066   | 54049   | 84135   | 55509   | 83179   | 56952   | 82198   | 17 |
| 44 | 104     | 956    | 597     | 051     | 073     | 120     | 533     | 163     | 976     | 181     | 16 |
| 45 | 129     | 941    | 621     | 035     | 097     | 104     | 557     | 147     | 57000   | 165     | 15 |
| 46 | 154     | 926    | 646     | 020     | 122     | 088     | 581     | 131     | 024     | 148     | 14 |
| 47 | 179     | 911    | 671     | 005     | 146     | 072     | 605     | 115     | 047     | 132     | 13 |
| 48 | 204     | 896    | 696     | 84989   | 171     | 057     | 630     | 098     | 071     | 115     | 12 |
| 49 | 51229   | 85881  | 52720   | 84974   | 54195   | 84041   | 55654   | 83082   | 57095   | 82098   | 11 |
| 50 | 254     | 866    | 745     | 959     | 220     | 025     | 678     | 066     | 119     | 082     | 10 |
| 51 | 279     | 851    | 770     | 943     | 244     | 009     | 702     | 050     | 143     | 065     | 9  |
| 52 | 304     | 836    | 794     | 928     | 269     | 83994   | 726     | 034     | 167     | 048     | 8  |
| 53 | 329     | 821    | 819     | 913     | 293     | 978     | 750     | 017     | 191     | 032     | 7  |
| 54 | 354     | 806    | 844     | 897     | 317     | 962     | 775     | 001     | 215     | 015     | 6  |
| 55 | 51379   | 85792  | 52869   | 84882   | 54342   | 83946   | 55799   | 82985   | 57238   | 81999   | 5  |
| 56 | 404     | 777    | 893     | 866     | 366     | 930     | 823     | 969     | 262     | 982     | 4  |
| 57 | 429     | 762    | 918     | 851     | 391     | 915     | 847     | 953     | 286     | 965     | 3  |
| 58 | 454     | 747    | 943     | 836     | 415     | 899     | 871     | 936     | 310     | 949     | 2  |
| 59 | 479     | 732    | 967     | 820     | 440     | 883     | 895     | 920     | 334     | 932     | 1  |
| M  | N. col. | N fine | N. col. | N fine  | N. col. | N fine  | N. col. | N fine  | N. col. | N fine  | M. |
|    | 59°     |        | 58°     |         | 57°     |         | 56°     |         | 55°     |         |    |

TABLE VIII. OF NATURAL SINES.

| M. | 35°    |        | 36°    |        | 37°    |        | 38°    |        | 39°    |        | M. |
|----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|----|
|    | N fine | N col. | N fine | N col. | N fine | N col. | N fine | N col. | N fine | N col. |    |
| 0  | 57358  | 81915  | 58779  | 80902  | 60181  | 79864  | 61566  | 78801  | 62932  | 77715  | 60 |
| 1  | 381    | 899    | 802    | 885    | 205    | 846    | 589    | 783    | 955    | 696    | 59 |
| 2  | 405    | 882    | 826    | 867    | 228    | 829    | 612    | 765    | 977    | 678    | 58 |
| 3  | 429    | 865    | 849    | 850    | 251    | 811    | 635    | 747    | 63000  | 660    | 57 |
| 4  | 453    | 848    | 873    | 833    | 274    | 793    | 658    | 729    | 022    | 641    | 56 |
| 5  | 477    | 832    | 896    | 816    | 298    | 776    | 681    | 711    | 045    | 623    | 55 |
| 6  | 501    | 815    | 920    | 799    | 321    | 758    | 704    | 693    | 068    | 605    | 54 |
| 7  | 57524  | 81798  | 58943  | 80782  | 60344  | 79741  | 61726  | 78676  | 63090  | 77586  | 53 |
| 8  | 548    | 781    | 967    | 765    | 367    | 723    | 749    | 658    | 113    | 568    | 52 |
| 9  | 572    | 765    | 999    | 748    | 390    | 706    | 772    | 640    | 135    | 550    | 51 |
| 10 | 596    | 748    | 59014  | 730    | 414    | 688    | 795    | 622    | 158    | 531    | 50 |
| 11 | 619    | 731    | 037    | 713    | 437    | 671    | 818    | 604    | 180    | 513    | 49 |
| 12 | 643    | 714    | 061    | 696    | 460    | 653    | 841    | 586    | 203    | 494    | 48 |
| 13 | 57667  | 81698  | 59084  | 80679  | 60483  | 79635  | 61864  | 78568  | 63225  | 77476  | 47 |
| 14 | 691    | 681    | 107    | 662    | 506    | 618    | 887    | 550    | 248    | 458    | 46 |
| 15 | 715    | 664    | 131    | 644    | 529    | 600    | 909    | 532    | 271    | 439    | 45 |
| 16 | 738    | 647    | 154    | 627    | 553    | 583    | 932    | 514    | 293    | 421    | 44 |
| 17 | 762    | 631    | 178    | 610    | 576    | 565    | 955    | 496    | 316    | 402    | 43 |
| 18 | 786    | 614    | 201    | 593    | 599    | 547    | 978    | 478    | 338    | 384    | 42 |
| 19 | 57809  | 81597  | 59225  | 80576  | 60622  | 79530  | 62001  | 78460  | 63361  | 77366  | 41 |
| 20 | 833    | 580    | 248    | 558    | 645    | 512    | 024    | 442    | 383    | 347    | 40 |
| 21 | 857    | 563    | 272    | 541    | 668    | 494    | 046    | 424    | 406    | 329    | 39 |
| 22 | 881    | 546    | 295    | 524    | 691    | 477    | 069    | 405    | 428    | 310    | 38 |
| 23 | 904    | 530    | 318    | 507    | 714    | 459    | 092    | 387    | 451    | 292    | 37 |
| 24 | 928    | 513    | 342    | 489    | 738    | 441    | 115    | 369    | 473    | 273    | 36 |
| 25 | 57952  | 81496  | 59365  | 80472  | 60761  | 79424  | 62138  | 78351  | 63496  | 77255  | 35 |
| 26 | 976    | 479    | 389    | 455    | 784    | 406    | 160    | 333    | 518    | 236    | 34 |
| 27 | 999    | 462    | 412    | 438    | 807    | 388    | 183    | 315    | 540    | 218    | 33 |
| 28 | 58023  | 445    | 435    | 420    | 830    | 371    | 206    | 297    | 563    | 199    | 32 |
| 29 | 047    | 428    | 459    | 403    | 853    | 353    | 229    | 279    | 585    | 181    | 31 |
| 30 | 070    | 412    | 482    | 386    | 876    | 335    | 251    | 261    | 608    | 162    | 30 |
| 31 | 58094  | 81395  | 59506  | 80368  | 60899  | 79318  | 62274  | 78243  | 63630  | 77144  | 29 |
| 32 | 118    | 378    | 529    | 351    | 922    | 300    | 297    | 225    | 653    | 125    | 28 |
| 33 | 141    | 361    | 552    | 334    | 945    | 282    | 320    | 206    | 675    | 107    | 27 |
| 34 | 165    | 344    | 576    | 316    | 968    | 264    | 342    | 188    | 698    | 088    | 26 |
| 35 | 189    | 327    | 599    | 299    | 991    | 247    | 365    | 170    | 720    | 070    | 25 |
| 36 | 212    | 310    | 622    | 282    | 61015  | 229    | 388    | 152    | 742    | 051    | 24 |
| 37 | 58236  | 81293  | 59846  | 80264  | 61038  | 79211  | 62411  | 78134  | 63765  | 77033  | 23 |
| 38 | 260    | 276    | 669    | 247    | 061    | 193    | 433    | 116    | 787    | 014    | 22 |
| 39 | 283    | 259    | 693    | 230    | 084    | 176    | 456    | 098    | 810    | 76996  | 21 |
| 40 | 307    | 242    | 716    | 212    | 107    | 158    | 479    | 079    | 832    | 977    | 20 |
| 41 | 330    | 225    | 739    | 195    | 130    | 140    | 502    | 061    | 854    | 959    | 19 |
| 42 | 354    | 208    | 763    | 178    | 153    | 122    | 524    | 043    | 877    | 940    | 18 |
| 43 | 58378  | 81191  | 59786  | 80160  | 61176  | 79105  | 62547  | 78025  | 63899  | 76921  | 17 |
| 44 | 401    | 174    | 809    | 143    | 199    | 087    | 570    | 007    | 922    | 903    | 16 |
| 45 | 425    | 157    | 832    | 125    | 222    | 069    | 592    | 77988  | 944    | 884    | 15 |
| 46 | 449    | 140    | 856    | 108    | 245    | 051    | 615    | 970    | 966    | 866    | 14 |
| 47 | 472    | 123    | 879    | 091    | 268    | 033    | 638    | 952    | 989    | 847    | 13 |
| 48 | 496    | 106    | 902    | 073    | 291    | 015    | 660    | 934    | 64011  | 828    | 12 |
| 49 | 58519  | 81089  | 59926  | 80056  | 61314  | 78998  | 62683  | 77916  | 64033  | 76810  | 11 |
| 50 | 543    | 072    | 949    | 038    | 337    | 980    | 706    | 897    | 056    | 791    | 10 |
| 51 | 567    | 055    | 972    | 021    | 360    | 962    | 728    | 879    | 078    | 772    | 9  |
| 52 | 590    | 038    | 995    | 003    | 383    | 944    | 751    | 861    | 100    | 754    | 8  |
| 53 | 614    | 021    | 60019  | 79986  | 406    | 926    | 774    | 843    | 123    | 735    | 7  |
| 54 | 637    | 004    | 042    | 968    | 429    | 908    | 796    | 824    | 145    | 717    | 6  |
| 55 | 58661  | 80987  | 60065  | 79951  | 61451  | 78891  | 62819  | 77806  | 64167  | 76698  | 5  |
| 56 | 684    | 970    | 089    | 934    | 474    | 873    | 842    | 788    | 190    | 679    | 4  |
| 57 | 708    | 953    | 112    | 916    | 497    | 855    | 864    | 769    | 212    | 661    | 3  |
| 58 | 731    | 936    | 135    | 899    | 520    | 837    | 887    | 751    | 234    | 642    | 2  |
| 59 | 755    | 919    | 158    | 881    | 543    | 819    | 909    | 733    | 256    | 623    | 1  |
| M. | N col. | N fine | N col. | N fine | N col. | N fine | N col. | N fine | N col. | N fine | M. |
|    | 54°    |        | 53°    |        | 22°    |        | 51°    |        | 50°    |        |    |



TABLE VIII. OF NATURAL SINES.

|    | 40°     | 41°     | 42°     | 43°     | 44°     |         |
|----|---------|---------|---------|---------|---------|---------|
| M. | N. fine | N. col  | N. fine | N. col  | N. fine | N. col  |
| 0  | 64279   | 76604   | 65606   | 75471   | 66913   | 74314   |
| 1  | 301     | 586     | 628     | 452     | 935     | 221     |
| 2  | 323     | 567     | 650     | 433     | 956     | 242     |
| 3  | 346     | 548     | 672     | 414     | 978     | 264     |
| 4  | 368     | 530     | 694     | 395     | 999     | 237     |
| 5  | 390     | 511     | 716     | 375     | 67021   | 217     |
| 6  | 412     | 492     | 738     | 356     | 043     | 198     |
| 7  | 64435   | 76473   | 65759   | 75337   | 67064   | 74178   |
| 8  | 457     | 455     | 781     | 318     | 086     | 159     |
| 9  | 479     | 436     | 803     | 299     | 107     | 139     |
| 10 | 501     | 417     | 825     | 280     | 129     | 120     |
| 11 | 524     | 398     | 847     | 261     | 151     | 100     |
| 12 | 546     | 380     | 869     | 241     | 172     | 080     |
| 13 | 64568   | 76361   | 65891   | 75222   | 67194   | 74061   |
| 14 | 590     | 342     | 913     | 203     | 215     | 041     |
| 15 | 612     | 323     | 935     | 184     | 237     | 022     |
| 16 | 635     | 304     | 956     | 165     | 258     | 002     |
| 17 | 657     | 286     | 978     | 146     | 280     | 73983   |
| 18 | 679     | 267     | 66000   | 126     | 301     | 963     |
| 19 | 64701   | 76248   | 66022   | 75107   | 67323   | 73944   |
| 20 | 723     | 229     | 044     | 088     | 344     | 924     |
| 21 | 746     | 210     | 066     | 069     | 366     | 904     |
| 22 | 768     | 192     | 088     | 050     | 387     | 885     |
| 23 | 790     | 173     | 109     | 030     | 409     | 865     |
| 24 | 812     | 154     | 131     | 011     | 430     | 846     |
| 25 | 64834   | 76135   | 66153   | 74992   | 67452   | 73826   |
| 26 | 856     | 116     | 175     | 973     | 473     | 806     |
| 27 | 878     | 097     | 197     | 953     | 494     | 787     |
| 28 | 901     | 078     | 218     | 934     | 516     | 767     |
| 29 | 923     | 059     | 240     | 915     | 538     | 747     |
| 30 | 945     | 041     | 262     | 896     | 559     | 728     |
| 31 | 64967   | 76022   | 66284   | 74876   | 67580   | 73708   |
| 32 | 989     | 003     | 306     | 857     | 602     | 688     |
| 33 | 65011   | 75984   | 327     | 838     | 623     | 669     |
| 34 | 033     | 965     | 349     | 818     | 645     | 649     |
| 35 | 055     | 946     | 371     | 799     | 666     | 629     |
| 36 | 077     | 927     | 393     | 780     | 688     | 610     |
| 37 | 65099   | 75908   | 66414   | 74760   | 67709   | 73590   |
| 38 | 122     | 889     | 436     | 741     | 730     | 69004   |
| 39 | 144     | 870     | 458     | 722     | 752     | 551     |
| 40 | 166     | 851     | 480     | 703     | 773     | 531     |
| 41 | 188     | 832     | 501     | 683     | 795     | 511     |
| 42 | 210     | 813     | 523     | 664     | 816     | 491     |
| 43 | 65232   | 75794   | 66545   | 74644   | 67837   | 73472   |
| 44 | 254     | 775     | 566     | 625     | 859     | 452     |
| 45 | 276     | 756     | 588     | 606     | 880     | 432     |
| 46 | 298     | 738     | 610     | 586     | 901     | 412     |
| 47 | 320     | 719     | 632     | 567     | 923     | 393     |
| 48 | 342     | 699     | 653     | 548     | 944     | 373     |
| 49 | 65364   | 75680   | 66675   | 74528   | 67965   | 73353   |
| 50 | 386     | 661     | 697     | 509     | 987     | 333     |
| 51 | 408     | 642     | 718     | 489     | 68008   | 314     |
| 52 | 430     | 623     | 740     | 470     | 029     | 294     |
| 53 | 452     | 604     | 762     | 451     | 051     | 274     |
| 54 | 474     | 585     | 783     | 431     | 072     | 254     |
| 55 | 65496   | 75566   | 66805   | 74412   | 68093   | 73234   |
| 56 | 518     | 547     | 827     | 392     | 115     | 215     |
| 57 | 540     | 528     | 848     | 373     | 136     | 195     |
| 58 | 562     | 509     | 870     | 353     | 157     | 175     |
| 59 | 584     | 490     | 891     | 334     | 179     | 155     |
| M. | N. col  | N. fine | N. col  | N. fine | N. col  | N. fine |
|    | 49°     | 48°     | 47°     | 46°     | 45°     |         |

TABLE IX. PROPORTIONAL LOGARITHMS.

| S  | h<br>° 0' | h<br>° 1' | h<br>° 2' | h<br>° 3' | h<br>° 4' | h<br>° 5' | h<br>° 6' | h<br>° 7' | h<br>° 8' |
|----|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 0  |           | 2.2553    | 1.9542    | 1.7782    | 1.6532    | 1.5563    | 1.4771    | 1.4102    | 1.3522    |
| 1  | 4.0334    | 2481      | 9506      | 7757      | 6514      | 5548      | 4759      | 4091      | 3513      |
| 2  | 3.7324    | 2410      | 9470      | 7733      | 6496      | 5534      | 4747      | 4081      | 3504      |
| 3  | 3.5563    | 2341      | 9435      | 7710      | 6478      | 5520      | 4735      | 4071      | 3495      |
| 4  | 3.4313    | 2272      | 9400      | 7686      | 6460      | 5505      | 4723      | 4070      | 3486      |
| 5  | 3.3344    | 2205      | 9365      | 7662      | 6442      | 5491      | 4711      | 4050      | 3477      |
| 6  | 3.2553    | 2139      | 9331      | 7639      | 6425      | 5477      | 4699      | 4040      | 3468      |
| 7  | 3.1883    | 2073      | 9296      | 7616      | 6407      | 5463      | 4687      | 4030      | 3459      |
| 8  | 3.1303    | 2009      | 9262      | 7592      | 6390      | 5449      | 4676      | 4020      | 3450      |
| 9  | 3.0792    | 1946      | 9228      | 7570      | 6372      | 5435      | 4664      | 4010      | 3441      |
| 10 | 3.0334    | 2.1883    | 1.9195    | 1.7546    | 1.6355    | 1.5420    | 1.4652    | 1.3999    | 1.3432    |
| 11 | 2.9920    | 1821      | 9161      | 7524      | 6337      | 5406      | 4640      | 3989      | 3423      |
| 12 | 9542      | 1761      | 9128      | 7501      | 6320      | 5393      | 4629      | 3979      | 3415      |
| 13 | 9195      | 1701      | 9096      | 7478      | 6303      | 5379      | 4617      | 3969      | 3406      |
| 14 | 8873      | 1642      | 9063      | 7456      | 6286      | 5365      | 4605      | 3959      | 3397      |
| 15 | 8573      | 1584      | 9031      | 7434      | 6269      | 5351      | 4594      | 3949      | 3388      |
| 16 | 8293      | 1526      | 8999      | 7411      | 6252      | 5337      | 4582      | 3939      | 3379      |
| 17 | 8030      | 1469      | 8967      | 7389      | 6235      | 5323      | 4571      | 3929      | 3370      |
| 18 | 7782      | 1413      | 8935      | 7368      | 6218      | 5310      | 4559      | 3919      | 3362      |
| 19 | 7546      | 1358      | 8904      | 7345      | 6201      | 5296      | 4548      | 3909      | 3353      |
| 20 | 2.7324    | 2.1303    | 1.8873    | 1.7324    | 1.6184    | 1.5283    | 1.4536    | 1.3899    | 1.3344    |
| 21 | 7112      | 1249      | 8842      | 7302      | 6168      | 5269      | 4525      | 3890      | 3336      |
| 22 | 6910      | 1196      | 8811      | 7281      | 6151      | 5255      | 4513      | 3880      | 3327      |
| 23 | 6717      | 1143      | 8781      | 7259      | 6134      | 5242      | 4502      | 3870      | 3318      |
| 24 | 6532      | 1091      | 8751      | 7238      | 6118      | 5229      | 4491      | 3860      | 3310      |
| 25 | 6355      | 1040      | 8720      | 7216      | 6102      | 5215      | 4479      | 3850      | 3301      |
| 26 | 6184      | 0989      | 8690      | 7195      | 6085      | 5202      | 4468      | 3841      | 3293      |
| 27 | 6021      | 0939      | 8661      | 7175      | 6065      | 5189      | 4457      | 3831      | 3284      |
| 28 | 5862      | 0889      | 8631      | 7153      | 6053      | 5175      | 4446      | 3821      | 3275      |
| 29 | 5710      | 0840      | 8602      | 7133      | 6037      | 5162      | 4435      | 3812      | 3267      |
| 30 | 2.5563    | 2.0792    | 1.8573    | 1.7112    | 1.6021    | 1.5149    | 1.4424    | 1.3802    | 1.3259    |
| 31 | 5420      | 0744      | 8544      | 7091      | 6004      | 5136      | 4412      | 3792      | 3250      |
| 32 | 5283      | 0696      | 8516      | 7071      | 5988      | 5123      | 4401      | 3783      | 3241      |
| 33 | 5149      | 0649      | 8487      | 7050      | 5973      | 5110      | 4390      | 3773      | 3233      |
| 34 | 5019      | 0603      | 8459      | 7030      | 5957      | 5097      | 4379      | 3763      | 3224      |
| 35 | 4893      | 0557      | 8431      | 7010      | 5941      | 5084      | 4368      | 3754      | 3216      |
| 36 | 4771      | 0512      | 8403      | 6990      | 5925      | 5071      | 4357      | 3745      | 3208      |
| 37 | 4652      | 0466      | 8375      | 6969      | 5909      | 5058      | 4346      | 3735      | 3199      |
| 38 | 4536      | 0422      | 8347      | 6949      | 5894      | 5045      | 4335      | 3725      | 3191      |
| 39 | 4424      | 0378      | 8320      | 6930      | 5878      | 5032      | 4325      | 3716      | 3183      |
| 40 | 2.4313    | 2.0334    | 1.8293    | 1.6910    | 1.5862    | 1.5019    | 1.4313    | 1.3706    | 1.3174    |
| 41 | 4206      | 0291      | 8266      | 6890      | 5847      | 5006      | 4303      | 3697      | 3166      |
| 42 | 4102      | 0248      | 8239      | 6871      | 5832      | 4994      | 4292      | 3688      | 3158      |
| 43 | 3999      | 0206      | 8212      | 6851      | 5816      | 4981      | 4281      | 3678      | 3149      |
| 44 | 3899      | 0164      | 8186      | 6832      | 5801      | 4968      | 4270      | 3669      | 3141      |
| 45 | 3802      | 0122      | 8159      | 6812      | 5786      | 4956      | 4260      | 3660      | 3133      |
| 46 | 3706      | 0081      | 8133      | 6793      | 5770      | 4943      | 4249      | 3650      | 3124      |
| 47 | 3613      | 0040      | 8107      | 6774      | 5755      | 4931      | 4238      | 3641      | 3116      |
| 48 | 3522      | 0000      | 8081      | 6755      | 5740      | 4918      | 4228      | 3632      | 3108      |
| 49 | 3432      | 1.9960    | 8055      | 6736      | 5725      | 4906      | 4217      | 3622      | 3099      |
| 50 | 2.3344    | 1.9920    | 1.8030    | 1.6717    | 1.5710    | 1.4893    | 1.4206    | 1.3613    | 1.3091    |
| 51 | 3259      | 9881      | 8004      | 6698      | 5695      | 4881      | 4196      | 3604      | 3083      |
| 52 | 3174      | 9842      | 7979      | 6679      | 5680      | 4869      | 4185      | 3595      | 3075      |
| 53 | 3091      | 9803      | 7954      | 6660      | 5665      | 4856      | 4175      | 3585      | 3067      |
| 54 | 3010      | 9765      | 7929      | 6642      | 5651      | 4844      | 4165      | 3576      | 3059      |
| 55 | 2930      | 9727      | 7904      | 6623      | 5636      | 4832      | 4154      | 3567      | 3050      |
| 56 | 2852      | 9689      | 7879      | 6605      | 5621      | 4820      | 4143      | 3558      | 3042      |
| 57 | 2775      | 9652      | 7855      | 6587      | 5607      | 4808      | 4133      | 3549      | 3034      |
| 58 | 2700      | 9615      | 7830      | 6568      | 5592      | 4795      | 4122      | 3540      | 3026      |
| 59 | 2626      | 9579      | 7805      | 6550      | 5577      | 4783      | 4112      | 3531      | 3018      |
| 60 | 2.2553    | 1.9542    | 1.7782    | 1.6532    | 1.5563    | 1.4771    | 1.4102    | 1.3522    | 1.3010    |

TABLE IX. PROPORTIONAL LOGARITHMS.

| S  | h<br>° 9' | h<br>° 10' | h<br>° 11' | h<br>° 12' | h<br>° 13' | h<br>° 14' | h<br>° 15' | h<br>° 16' | h<br>° 17' |
|----|-----------|------------|------------|------------|------------|------------|------------|------------|------------|
| 0  | 1.3010    | 1.2553     | 1.2139     | 1.1761     | 1.1413     | 1.1091     | 1.0792     | 1.0512     | 1.0248     |
| 1  | 3002      | 2545       | 2132       | 1755       | 1408       | 1086       | 0787       | 0507       | 0244       |
| 2  | 2994      | 2538       | 2125       | 1749       | 1402       | 1081       | 0782       | 0502       | 0240       |
| 3  | 2986      | 2531       | 2119       | 1743       | 1397       | 1076       | 0777       | 0498       | 0235       |
| 4  | 2978      | 2524       | 2112       | 1737       | 1391       | 1071       | 0772       | 0493       | 0231       |
| 5  | 2970      | 2517       | 2106       | 1731       | 1385       | 1066       | 0768       | 0489       | 0227       |
| 6  | 2962      | 2510       | 2099       | 1725       | 1380       | 1061       | 0763       | 0484       | 0223       |
| 7  | 2954      | 2502       | 2093       | 1719       | 1374       | 1055       | 0758       | 0480       | 0218       |
| 8  | 2946      | 2495       | 2086       | 1713       | 1369       | 1050       | 0753       | 0475       | 0214       |
| 9  | 2939      | 2488       | 2080       | 1707       | 1363       | 1045       | 0749       | 0471       | 0210       |
| 10 | 1.2931    | 1.2481     | 1.2073     | 1.1701     | 1.1358     | 1.1040     | 1.0744     | 1.0466     | 1.0206     |
| 11 | 2923      | 2474       | 2067       | 1695       | 1352       | 1035       | 0739       | 0462       | 0201       |
| 12 | 2915      | 2467       | 2061       | 1689       | 1347       | 1030       | 0734       | 0458       | 0197       |
| 13 | 2907      | 2459       | 2054       | 1683       | 1341       | 1025       | 0729       | 0453       | 0193       |
| 14 | 2899      | 2452       | 2047       | 1677       | 1336       | 1020       | 0725       | 0448       | 0189       |
| 15 | 2891      | 2445       | 2041       | 1671       | 1331       | 1015       | 0720       | 0444       | 0185       |
| 16 | 2883      | 2438       | 2035       | 1665       | 1325       | 1009       | 0715       | 0440       | 0180       |
| 17 | 2875      | 2431       | 2028       | 1659       | 1319       | 1004       | 0710       | 0435       | 0176       |
| 18 | 2868      | 2424       | 2022       | 1654       | 1314       | 0999       | 0706       | 0431       | 0172       |
| 19 | 2860      | 2417       | 2015       | 1648       | 1309       | 0994       | 0701       | 0426       | 0168       |
| 20 | 1.2852    | 1.2410     | 1.2009     | 1.1642     | 1.1303     | 1.0989     | 1.0696     | 1.0422     | 1.0164     |
| 21 | 2845      | 2403       | 2003       | 1636       | 1298       | 0984       | 0692       | 0418       | 0160       |
| 22 | 2837      | 2396       | 1996       | 1630       | 1292       | 0979       | 0687       | 0413       | 0155       |
| 23 | 2829      | 2389       | 1990       | 1624       | 1287       | 0974       | 0682       | 0408       | 0151       |
| 24 | 2821      | 2382       | 1984       | 1619       | 1282       | 0969       | 0678       | 0404       | 0147       |
| 25 | 2814      | 2375       | 1977       | 1613       | 1276       | 0964       | 0673       | 0400       | 0143       |
| 26 | 2806      | 2368       | 1971       | 1607       | 1271       | 0959       | 0668       | 0395       | 0139       |
| 27 | 2798      | 2362       | 1965       | 1601       | 1266       | 0954       | 0663       | 0391       | 0135       |
| 28 | 2791      | 2355       | 1958       | 1595       | 1260       | 0949       | 0659       | 0386       | 0130       |
| 29 | 2783      | 2348       | 1952       | 1589       | 1255       | 0944       | 0654       | 0382       | 0126       |
| 30 | 1.2775    | 1.2341     | 1.1946     | 1.1584     | 1.1249     | 1.0939     | 1.0649     | 1.0378     | 1.0122     |
| 31 | 2768      | 2334       | 1939       | 1578       | 1244       | 0934       | 0645       | 0373       | 0118       |
| 32 | 2760      | 2327       | 1933       | 1572       | 1238       | 0929       | 0640       | 0369       | 0114       |
| 33 | 2753      | 2320       | 1927       | 1566       | 1233       | 0924       | 0635       | 0365       | 0110       |
| 34 | 2745      | 2313       | 1920       | 1560       | 1228       | 0919       | 0631       | 0360       | 0106       |
| 35 | 2737      | 2306       | 1914       | 1555       | 1222       | 0914       | 0626       | 0356       | 0102       |
| 36 | 2730      | 2300       | 1908       | 1549       | 1217       | 0909       | 0621       | 0352       | 0098       |
| 37 | 2722      | 2293       | 1902       | 1543       | 1212       | 0904       | 0617       | 0347       | 0093       |
| 38 | 2715      | 2286       | 1895       | 1537       | 1206       | 0899       | 0612       | 0343       | 0089       |
| 39 | 2707      | 2279       | 1889       | 1532       | 1201       | 0894       | 0608       | 0339       | 0085       |
| 40 | 1.2700    | 1.2272     | 1.1883     | 1.1526     | 1.1196     | 1.0889     | 1.0603     | 1.0334     | 1.0081     |
| 41 | 2692      | 2265       | 1877       | 1520       | 1191       | 0884       | 0598       | 0330       | 0077       |
| 42 | 2685      | 2259       | 1871       | 1515       | 1186       | 0880       | 0594       | 0326       | 0073       |
| 43 | 2677      | 2252       | 1864       | 1509       | 1180       | 0875       | 0589       | 0321       | 0069       |
| 44 | 2670      | 2245       | 1858       | 1503       | 1175       | 0870       | 0584       | 0317       | 0065       |
| 45 | 2663      | 2239       | 1852       | 1498       | 1170       | 0865       | 0580       | 0313       | 0061       |
| 46 | 2655      | 2232       | 1846       | 1492       | 1164       | 0860       | 0575       | 0308       | 0057       |
| 47 | 2648      | 2225       | 1840       | 1486       | 1159       | 0855       | 0571       | 0304       | 0053       |
| 48 | 2640      | 2218       | 1834       | 1481       | 1154       | 0850       | 0566       | 0300       | 0049       |
| 49 | 2633      | 2212       | 1828       | 1475       | 1148       | 0845       | 0561       | 0295       | 0044       |
| 50 | 1.2626    | 1.2205     | 1.1822     | 1.1469     | 1.1143     | 1.0840     | 1.0557     | 1.0291     | 1.0040     |
| 51 | 2618      | 2198       | 1816       | 1464       | 1138       | 0835       | 0552       | 0287       | 0036       |
| 52 | 2611      | 2192       | 1809       | 1458       | 1133       | 0830       | 0548       | 0282       | 0032       |
| 53 | 2603      | 2185       | 1803       | 1452       | 1128       | 0826       | 0543       | 0278       | 0028       |
| 54 | 2596      | 2178       | 1797       | 1447       | 1123       | 0821       | 0539       | 0274       | 0024       |
| 55 | 2589      | 2172       | 1791       | 1441       | 1117       | 0816       | 0534       | 0269       | 0020       |
| 56 | 2582      | 2165       | 1785       | 1435       | 1112       | 0811       | 0529       | 0265       | 0016       |
| 57 | 2574      | 2159       | 1779       | 1430       | 1107       | 0806       | 0525       | 0261       | 0012       |
| 58 | 2567      | 2152       | 1773       | 1424       | 1102       | 0801       | 0520       | 0257       | 0008       |
| 59 | 2560      | 2145       | 1767       | 1419       | 1096       | 0796       | 0516       | 0252       | 0004       |
| 60 | 1.2553    | 1.2139     | 1.1761     | 1.1413     | 1.1091     | 1.0792     | 1.0512     | 1.0248     | 1.0000     |



TABLE IX. PROPORTIONAL LOGARITHMS.

| S  | h<br>0° 18' | h<br>0° 19' | h<br>0° 20' | h<br>0° 21' | h<br>0° 22' | h<br>0° 23' | h<br>0° 24' | h<br>0° 25' | h<br>0° 26' | h<br>0° 27' | h<br>0° 28' | h<br>0° 29' |
|----|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 0  | 10000       | 9765        | 9542        | 9331        | 9128        | 8935        | 8751        | 8573        | 8403        | 8239        | 8081        | 7929        |
| 1  | 9996        | 9761        | 9539        | 9327        | 9125        | 8932        | 8748        | 8570        | 8400        | 8236        | 8078        | 7926        |
| 2  | 9992        | 9757        | 9535        | 9323        | 9122        | 8929        | 8745        | 8567        | 8397        | 8234        | 8076        | 7924        |
| 3  | 9988        | 9754        | 9532        | 9320        | 9119        | 8926        | 8742        | 8565        | 8395        | 8231        | 8073        | 7921        |
| 4  | 9984        | 9750        | 9528        | 9317        | 9115        | 8923        | 8739        | 8562        | 8392        | 8228        | 8071        | 7919        |
| 5  | 9980        | 9746        | 9524        | 9313        | 9112        | 8920        | 8730        | 8559        | 8389        | 8225        | 8068        | 7916        |
| 6  | 9976        | 9742        | 9521        | 9310        | 9109        | 8917        | 8733        | 8556        | 8386        | 8223        | 8066        | 7914        |
| 7  | 9972        | 9738        | 9517        | 9306        | 9105        | 8913        | 8730        | 8553        | 8383        | 8220        | 8063        | 7911        |
| 8  | 9968        | 9735        | 9513        | 9303        | 9102        | 8910        | 8727        | 8550        | 8381        | 8217        | 8060        | 7909        |
| 9  | 9964        | 9731        | 9510        | 9300        | 9099        | 8907        | 8724        | 8547        | 8378        | 8215        | 8058        | 7906        |
| 10 | 9960        | 9727        | 9506        | 9296        | 9096        | 8904        | 8721        | 8544        | 8375        | 8212        | 8055        | 7904        |
| 11 | 9956        | 9723        | 9503        | 9293        | 9092        | 8901        | 8718        | 8541        | 8372        | 8209        | 8053        | 7901        |
| 12 | 9952        | 9720        | 9499        | 9289        | 9089        | 8898        | 8715        | 8539        | 8370        | 8207        | 8050        | 7899        |
| 13 | 9948        | 9716        | 9495        | 9286        | 9086        | 8895        | 8712        | 8536        | 8367        | 8204        | 8047        | 7896        |
| 14 | 9944        | 9712        | 9492        | 9282        | 9082        | 8891        | 8709        | 8533        | 8364        | 8202        | 8045        | 7894        |
| 15 | 9940        | 9708        | 9488        | 9279        | 9079        | 8888        | 8706        | 8530        | 8361        | 8199        | 8043        | 7891        |
| 16 | 9936        | 9704        | 9485        | 9276        | 9076        | 8885        | 8703        | 8527        | 8358        | 8196        | 8040        | 7889        |
| 17 | 9932        | 9701        | 9481        | 9272        | 9073        | 8882        | 8700        | 8524        | 8356        | 8194        | 8037        | 7886        |
| 18 | 9928        | 9697        | 9478        | 9269        | 9070        | 8879        | 8697        | 8522        | 8353        | 8191        | 8035        | 7884        |
| 19 | 9924        | 9693        | 9474        | 9265        | 9066        | 8876        | 8694        | 8519        | 8350        | 8188        | 8032        | 7881        |
| 20 | 9920        | 9689        | 9470        | 9262        | 9063        | 8873        | 8691        | 8516        | 8347        | 8186        | 8030        | 7879        |
| 21 | 9916        | 9686        | 9467        | 9259        | 9060        | 8870        | 8688        | 8513        | 8345        | 8183        | 8027        | 7877        |
| 22 | 9912        | 9682        | 9463        | 9255        | 9056        | 8867        | 8685        | 8510        | 8342        | 8180        | 8024        | 7874        |
| 23 | 9908        | 9678        | 9460        | 9252        | 9053        | 8864        | 8682        | 8507        | 8339        | 8178        | 8022        | 7872        |
| 24 | 9905        | 9675        | 9456        | 9249        | 9050        | 8861        | 8679        | 8504        | 8337        | 8175        | 8020        | 7869        |
| 25 | 9901        | 9671        | 9453        | 9245        | 9047        | 8857        | 8676        | 8501        | 8334        | 8172        | 8017        | 7867        |
| 26 | 9897        | 9667        | 9449        | 9242        | 9044        | 8854        | 8673        | 8498        | 8331        | 8170        | 8014        | 7864        |
| 27 | 9893        | 9664        | 9446        | 9238        | 9041        | 8851        | 8670        | 8496        | 8328        | 8167        | 8012        | 7862        |
| 28 | 9889        | 9660        | 9442        | 9235        | 9037        | 8848        | 8667        | 8493        | 8326        | 8164        | 8009        | 7859        |
| 29 | 9885        | 9656        | 9439        | 9231        | 9034        | 8845        | 8664        | 8490        | 8323        | 8162        | 8007        | 7857        |
| 30 | 9881        | 9652        | 9435        | 9228        | 9031        | 8842        | 8661        | 8487        | 8320        | 8159        | 8004        | 7855        |
| 31 | 9877        | 9648        | 9431        | 9225        | 9027        | 8839        | 8658        | 8484        | 8317        | 8157        | 8002        | 7852        |
| 32 | 9873        | 9645        | 9428        | 9221        | 9024        | 8836        | 8655        | 8481        | 8315        | 8154        | 7999        | 7849        |
| 33 | 9869        | 9641        | 9425        | 9218        | 9021        | 8833        | 8652        | 8479        | 8312        | 8152        | 7997        | 7847        |
| 34 | 9865        | 9637        | 9421        | 9215        | 9018        | 8830        | 8649        | 8476        | 8309        | 8149        | 7994        | 7844        |
| 35 | 9861        | 9634        | 9417        | 9211        | 9015        | 8827        | 8646        | 8473        | 8306        | 8146        | 7991        | 7842        |
| 36 | 9858        | 9630        | 9414        | 9208        | 9012        | 8824        | 8643        | 8470        | 8304        | 8144        | 7989        | 7840        |
| 37 | 9854        | 9626        | 9410        | 9205        | 9008        | 8820        | 8640        | 8467        | 8301        | 8141        | 7986        | 7837        |
| 38 | 9850        | 9623        | 9407        | 9201        | 9005        | 8817        | 8637        | 8464        | 8298        | 8138        | 7984        | 7835        |
| 39 | 9846        | 9619        | 9404        | 9198        | 9002        | 8814        | 8635        | 8462        | 8296        | 8136        | 7981        | 7832        |
| 40 | 9842        | 9615        | 9400        | 9195        | 8999        | 8811        | 8632        | 8459        | 8293        | 8133        | 7979        | 7830        |
| 41 | 9838        | 9612        | 9396        | 9191        | 8995        | 8808        | 8629        | 8456        | 8290        | 8130        | 7976        | 7827        |
| 42 | 9834        | 9608        | 9393        | 9188        | 8992        | 8805        | 8626        | 8453        | 8288        | 8128        | 7974        | 7825        |
| 43 | 9830        | 9604        | 9389        | 9185        | 8989        | 8802        | 8623        | 8450        | 8285        | 8125        | 7971        | 7823        |
| 44 | 9826        | 9601        | 9386        | 9181        | 8986        | 8799        | 8620        | 8448        | 8282        | 8122        | 7969        | 7820        |
| 45 | 9823        | 9597        | 9383        | 9178        | 8983        | 8796        | 8617        | 8445        | 8279        | 8120        | 7966        | 7818        |
| 46 | 9819        | 9593        | 9379        | 9175        | 8980        | 8793        | 8614        | 8442        | 8277        | 8117        | 7964        | 7815        |
| 47 | 9815        | 9590        | 9375        | 9171        | 8976        | 8790        | 8611        | 8439        | 8274        | 8115        | 7961        | 7813        |
| 48 | 9811        | 9586        | 9372        | 9168        | 8973        | 8787        | 8608        | 8437        | 8271        | 8112        | 7959        | 7811        |
| 49 | 9807        | 9582        | 9368        | 9165        | 8970        | 8784        | 8605        | 8434        | 8268        | 8109        | 7956        | 7808        |
| 50 | 9803        | 9579        | 9365        | 9161        | 8967        | 8781        | 8602        | 8431        | 8266        | 8107        | 7954        | 7805        |
| 51 | 9800        | 9575        | 9362        | 9158        | 8964        | 8778        | 8599        | 8428        | 8263        | 8104        | 7951        | 7803        |
| 52 | 9796        | 9571        | 9358        | 9155        | 8960        | 8775        | 8596        | 8425        | 8260        | 8102        | 7949        | 7801        |
| 53 | 9792        | 9568        | 9355        | 9151        | 8957        | 8772        | 8593        | 8422        | 8258        | 8099        | 7946        | 7798        |
| 54 | 9788        | 9564        | 9351        | 9148        | 8954        | 8769        | 8591        | 8420        | 8255        | 8097        | 7944        | 7796        |
| 55 | 9784        | 9560        | 9348        | 9145        | 8951        | 8766        | 8588        | 8417        | 8252        | 8094        | 7941        | 7793        |
| 56 | 9780        | 9557        | 9344        | 9141        | 8948        | 8763        | 8585        | 8414        | 8250        | 8091        | 7939        | 7791        |
| 57 | 9777        | 9553        | 9341        | 9138        | 8945        | 8760        | 8582        | 8411        | 8247        | 8089        | 7936        | 7789        |
| 58 | 9773        | 9549        | 9337        | 9135        | 8942        | 8757        | 8579        | 8408        | 8244        | 8086        | 7934        | 7786        |
| 59 | 9769        | 9546        | 9334        | 9132        | 8938        | 8754        | 8576        | 8406        | 8242        | 8084        | 7931        | 7784        |
| 60 | 9765        | 9542        | 9331        | 9128        | 8935        | 8751        | 8573        | 8403        | 8239        | 8081        | 7929        | 7782        |

TABLE IX. PROPORTIONAL LOGARITHMS.

| S  | h<br>0° 30' | h<br>0° 31' | h<br>0° 32' | h<br>0° 33' | h<br>0° 34' | h<br>0° 35' | h<br>0° 36' | h<br>0° 37' | h<br>0° 38' | h<br>0° 39' | h<br>0° 40' | h<br>0° 41' |
|----|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 0  | 7782        | 7639        | 7501        | 7368        | 7238        | 7112        | 6990        | 6871        | 6755        | 6642        | 6532        | 6425        |
| 1  | 7779        | 7637        | 7499        | 7365        | 7236        | 7110        | 6988        | 6869        | 6753        | 6640        | 6530        | 6423        |
| 2  | 7776        | 7634        | 7496        | 7363        | 7234        | 7108        | 6986        | 6867        | 6751        | 6638        | 6528        | 6421        |
| 3  | 7774        | 7632        | 7494        | 7361        | 7232        | 7106        | 6984        | 6865        | 6749        | 6637        | 6527        | 6420        |
| 4  | 7772        | 7630        | 7492        | 7359        | 7229        | 7104        | 6982        | 6863        | 6747        | 6635        | 6525        | 6418        |
| 5  | 7769        | 7627        | 7490        | 7356        | 7227        | 7102        | 6980        | 6861        | 6745        | 6633        | 6523        | 6416        |
| 6  | 7767        | 7625        | 7488        | 7354        | 7225        | 7100        | 6978        | 6859        | 6743        | 6631        | 6521        | 6414        |
| 7  | 7764        | 7623        | 7485        | 7352        | 7223        | 7097        | 6976        | 6857        | 6741        | 6629        | 6519        | 6412        |
| 8  | 7762        | 7620        | 7483        | 7350        | 7221        | 7095        | 6974        | 6855        | 6739        | 6627        | 6517        | 6410        |
| 9  | 7760        | 7618        | 7481        | 7348        | 7219        | 7093        | 6972        | 6853        | 6738        | 6625        | 6516        | 6409        |
| 10 | 7757        | 7616        | 7478        | 7345        | 7216        | 7091        | 6970        | 6851        | 6736        | 6623        | 6514        | 6407        |
| 11 | 7755        | 7613        | 7476        | 7343        | 7214        | 7089        | 6968        | 6849        | 6734        | 6621        | 6512        | 6405        |
| 12 | 7753        | 7611        | 7474        | 7341        | 7212        | 7087        | 6966        | 6847        | 6732        | 6620        | 6510        | 6403        |
| 13 | 7750        | 7609        | 7472        | 7339        | 7210        | 7085        | 6964        | 6845        | 6730        | 6618        | 6508        | 6401        |
| 14 | 7748        | 7606        | 7469        | 7337        | 7208        | 7083        | 6962        | 6843        | 6728        | 6616        | 6507        | 6400        |
| 15 | 7745        | 7604        | 7467        | 7335        | 7206        | 7081        | 6960        | 6841        | 6726        | 6614        | 6505        | 6398        |
| 16 | 7743        | 7602        | 7465        | 7332        | 7204        | 7079        | 6958        | 6839        | 6724        | 6612        | 6503        | 6396        |
| 17 | 7740        | 7599        | 7463        | 7330        | 7202        | 7077        | 6956        | 6837        | 6722        | 6610        | 6501        | 6394        |
| 18 | 7738        | 7597        | 7461        | 7328        | 7200        | 7075        | 6954        | 6836        | 6721        | 6609        | 6500        | 6393        |
| 19 | 7736        | 7595        | 7458        | 7326        | 7197        | 7073        | 6952        | 6834        | 6719        | 6607        | 6498        | 6391        |
| 20 | 7733        | 7592        | 7456        | 7324        | 7195        | 7071        | 6950        | 6832        | 6717        | 6605        | 6496        | 6389        |
| 21 | 7731        | 7590        | 7454        | 7322        | 7193        | 7069        | 6948        | 6830        | 6715        | 6603        | 6494        | 6387        |
| 22 | 7729        | 7588        | 7452        | 7319        | 7191        | 7067        | 6946        | 6828        | 6713        | 6601        | 6492        | 6385        |
| 23 | 7726        | 7586        | 7449        | 7317        | 7189        | 7065        | 6944        | 6826        | 6711        | 6599        | 6490        | 6383        |
| 24 | 7724        | 7583        | 7447        | 7315        | 7187        | 7063        | 6942        | 6824        | 6709        | 6598        | 6489        | 6381        |
| 25 | 7721        | 7581        | 7445        | 7313        | 7185        | 7061        | 6940        | 6822        | 6707        | 6596        | 6487        | 6379        |
| 26 | 7719        | 7579        | 7443        | 7311        | 7183        | 7059        | 6938        | 6820        | 6705        | 6594        | 6485        | 6377        |
| 27 | 7717        | 7577        | 7441        | 7309        | 7181        | 7057        | 6936        | 6818        | 6704        | 6592        | 6484        | 6375        |
| 28 | 7714        | 7574        | 7438        | 7306        | 7179        | 7054        | 6934        | 6816        | 6702        | 6590        | 6482        | 6373        |
| 29 | 7712        | 7572        | 7436        | 7304        | 7177        | 7052        | 6932        | 6814        | 6700        | 6588        | 6480        | 6371        |
| 30 | 7710        | 7570        | 7434        | 7302        | 7175        | 7050        | 6930        | 6812        | 6698        | 6587        | 6478        | 6370        |
| 31 | 7707        | 7567        | 7431        | 7300        | 7172        | 7048        | 6928        | 6810        | 6696        | 6585        | 6476        | 6369        |
| 32 | 7705        | 7565        | 7429        | 7298        | 7170        | 7046        | 6926        | 6808        | 6694        | 6583        | 6474        | 6367        |
| 33 | 7703        | 7563        | 7427        | 7296        | 7168        | 7044        | 6924        | 6807        | 6692        | 6581        | 6473        | 6365        |
| 34 | 7700        | 7560        | 7425        | 7293        | 7166        | 7042        | 6922        | 6805        | 6690        | 6579        | 6471        | 6363        |
| 35 | 7698        | 7558        | 7423        | 7291        | 7164        | 7040        | 6920        | 6803        | 6689        | 6577        | 6469        | 6361        |
| 36 | 7696        | 7556        | 7421        | 7289        | 7162        | 7038        | 6918        | 6801        | 6687        | 6576        | 6467        | 6359        |
| 37 | 7693        | 7553        | 7418        | 7287        | 7160        | 7036        | 6916        | 6799        | 6685        | 6574        | 6465        | 6357        |
| 38 | 7691        | 7551        | 7416        | 7285        | 7158        | 7034        | 6914        | 6797        | 6683        | 6572        | 6464        | 6355        |
| 39 | 7688        | 7549        | 7414        | 7283        | 7156        | 7032        | 6912        | 6795        | 6681        | 6570        | 6462        | 6353        |
| 40 | 7686        | 7546        | 7411        | 7281        | 7153        | 7030        | 6910        | 6793        | 6679        | 6568        | 6460        | 6351        |
| 41 | 7683        | 7544        | 7409        | 7278        | 7151        | 7028        | 6908        | 6791        | 6677        | 6566        | 6458        | 6349        |
| 42 | 7681        | 7542        | 7407        | 7276        | 7149        | 7026        | 6906        | 6789        | 6676        | 6565        | 6457        | 6347        |
| 43 | 7679        | 7540        | 7405        | 7274        | 7147        | 7024        | 6904        | 6787        | 6674        | 6563        | 6455        | 6345        |
| 44 | 7676        | 7537        | 7403        | 7272        | 7145        | 7022        | 6902        | 6785        | 6672        | 6561        | 6453        | 6343        |
| 45 | 7674        | 7535        | 7401        | 7270        | 7143        | 7020        | 6900        | 6784        | 6670        | 6559        | 6451        | 6341        |
| 46 | 7672        | 7533        | 7398        | 7268        | 7141        | 7018        | 6898        | 6782        | 6668        | 6557        | 6449        | 6339        |
| 47 | 7669        | 7531        | 7396        | 7266        | 7139        | 7016        | 6896        | 6780        | 6666        | 6556        | 6448        | 6337        |
| 48 | 7667        | 7528        | 7394        | 7264        | 7137        | 7014        | 6894        | 6778        | 6664        | 6554        | 6446        | 6335        |
| 49 | 7665        | 7526        | 7392        | 7261        | 7135        | 7012        | 6892        | 6776        | 6662        | 6552        | 6444        | 6333        |
| 50 | 7662        | 7524        | 7389        | 7259        | 7133        | 7010        | 6890        | 6774        | 6660        | 6550        | 6442        | 6331        |
| 51 | 7660        | 7522        | 7387        | 7257        | 7131        | 7008        | 6888        | 6772        | 6659        | 6548        | 6441        | 6329        |
| 52 | 7658        | 7519        | 7385        | 7255        | 7128        | 7006        | 6886        | 6770        | 6657        | 6546        | 6439        | 6327        |
| 53 | 7655        | 7517        | 7383        | 7253        | 7126        | 7004        | 6884        | 6768        | 6655        | 6545        | 6437        | 6325        |
| 54 | 7653        | 7515        | 7381        | 7251        | 7124        | 7002        | 6882        | 6766        | 6653        | 6543        | 6435        | 6323        |
| 55 | 7651        | 7512        | 7378        | 7248        | 7122        | 7000        | 6880        | 6764        | 6651        | 6541        | 6434        | 6321        |
| 56 | 7648        | 7510        | 7376        | 7246        | 7120        | 6998        | 6878        | 6762        | 6649        | 6539        | 6432        | 6319        |
| 57 | 7646        | 7508        | 7374        | 7244        | 7118        | 6996        | 6877        | 6761        | 6648        | 6538        | 6430        | 6317        |
| 58 | 7644        | 7506        | 7372        | 7242        | 7116        | 6994        | 6875        | 6759        | 6646        | 6536        | 6428        | 6315        |
| 59 | 7641        | 7503        | 7370        | 7240        | 7114        | 6992        | 6873        | 6757        | 6644        | 6534        | 6426        | 6313        |
| 60 | 7639        | 7501        | 7368        | 7238        | 7112        | 6990        | 6871        | 6755        | 6642        | 6532        | 6425        | 6310        |



TABLE IX. PROPORTIONAL LOGARITHMS.

|    | h<br>° 42' | h<br>° 43' | h<br>° 44' | h<br>° 45' | h<br>° 46' | h<br>° 47' | h<br>° 48' | h<br>° 49' | h<br>° 50' | h<br>° 51' | h<br>° 52' | h<br>° 53' |
|----|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 0  | 6320       | 6218       | 6118       | 6021       | 5925       | 5832       | 5740       | 5651       | 5563       | 5477       | 5393       | 5310       |
| 1  | 6318       | 6216       | 6116       | 6019       | 5923       | 5830       | 5739       | 5649       | 5561       | 5475       | 5391       | 5308       |
| 2  | 6317       | 6214       | 6115       | 6017       | 5922       | 5828       | 5737       | 5648       | 5560       | 5474       | 5390       | 5307       |
| 3  | 6315       | 6213       | 6113       | 6016       | 5920       | 5827       | 5736       | 5646       | 5559       | 5473       | 5389       | 5306       |
| 4  | 6313       | 6211       | 6111       | 6014       | 5919       | 5825       | 5734       | 5645       | 5557       | 5471       | 5387       | 5304       |
| 5  | 6311       | 6209       | 6110       | 6012       | 5917       | 5824       | 5733       | 5643       | 5556       | 5470       | 5386       | 5303       |
| 6  | 6310       | 6208       | 6108       | 6011       | 5916       | 5823       | 5731       | 5642       | 5554       | 5469       | 5384       | 5302       |
| 7  | 6308       | 6206       | 6106       | 6009       | 5914       | 5821       | 5730       | 5640       | 5553       | 5467       | 5383       | 5300       |
| 8  | 6306       | 6204       | 6105       | 6008       | 5912       | 5819       | 5728       | 5639       | 5551       | 5465       | 5381       | 5299       |
| 9  | 6305       | 6203       | 6103       | 6006       | 5911       | 5818       | 5727       | 5637       | 5550       | 5464       | 5380       | 5298       |
| 10 | 6303       | 6201       | 6102       | 6004       | 5909       | 5816       | 5725       | 5636       | 5548       | 5463       | 5379       | 5296       |
| 11 | 6301       | 6199       | 6100       | 6003       | 5908       | 5815       | 5724       | 5634       | 5547       | 5461       | 5377       | 5295       |
| 12 | 6300       | 6198       | 6099       | 6001       | 5906       | 5813       | 5722       | 5633       | 5546       | 5460       | 5376       | 5294       |
| 13 | 6298       | 6196       | 6097       | 6000       | 5905       | 5812       | 5721       | 5631       | 5544       | 5458       | 5374       | 5292       |
| 14 | 6296       | 6194       | 6095       | 5998       | 5903       | 5810       | 5719       | 5630       | 5543       | 5457       | 5373       | 5291       |
| 15 | 6294       | 6193       | 6094       | 5997       | 5902       | 5809       | 5718       | 5629       | 5541       | 5456       | 5372       | 5290       |
| 16 | 6293       | 6191       | 6092       | 5995       | 5900       | 5807       | 5716       | 5627       | 5540       | 5454       | 5370       | 5288       |
| 17 | 6291       | 6189       | 6090       | 5993       | 5898       | 5805       | 5715       | 5626       | 5538       | 5453       | 5369       | 5287       |
| 18 | 6289       | 6188       | 6089       | 5992       | 5897       | 5804       | 5713       | 5624       | 5537       | 5452       | 5368       | 5285       |
| 19 | 6287       | 6186       | 6087       | 5990       | 5895       | 5802       | 5712       | 5623       | 5535       | 5450       | 5366       | 5284       |
| 20 | 6286       | 6184       | 6085       | 5988       | 5894       | 5801       | 5710       | 5621       | 5534       | 5449       | 5365       | 5283       |
| 21 | 6284       | 6183       | 6084       | 5987       | 5892       | 5800       | 5709       | 5620       | 5533       | 5447       | 5364       | 5281       |
| 22 | 6282       | 6181       | 6082       | 5985       | 5890       | 5798       | 5707       | 5618       | 5531       | 5446       | 5362       | 5280       |
| 23 | 6281       | 6179       | 6080       | 5984       | 5889       | 5796       | 5706       | 5617       | 5530       | 5444       | 5361       | 5278       |
| 24 | 6279       | 6178       | 6079       | 5982       | 5888       | 5795       | 5704       | 5615       | 5528       | 5443       | 5359       | 5277       |
| 25 | 6277       | 6176       | 6077       | 5980       | 5886       | 5793       | 5703       | 5614       | 5527       | 5441       | 5358       | 5276       |
| 26 | 6275       | 6174       | 6075       | 5979       | 5884       | 5792       | 5701       | 5612       | 5525       | 5440       | 5356       | 5274       |
| 27 | 6274       | 6173       | 6074       | 5977       | 5883       | 5790       | 5700       | 5611       | 5524       | 5439       | 5355       | 5273       |
| 28 | 6272       | 6171       | 6072       | 5976       | 5881       | 5789       | 5698       | 5609       | 5522       | 5437       | 5354       | 5272       |
| 29 | 6270       | 6169       | 6071       | 5974       | 5880       | 5787       | 5697       | 5608       | 5521       | 5436       | 5352       | 5270       |
| 30 | 6269       | 6168       | 6069       | 5973       | 5878       | 5786       | 5695       | 5607       | 5520       | 5435       | 5351       | 5269       |
| 31 | 6267       | 6166       | 6067       | 5971       | 5876       | 5784       | 5694       | 5605       | 5518       | 5433       | 5350       | 5268       |
| 32 | 6265       | 6164       | 6066       | 5969       | 5875       | 5783       | 5693       | 5604       | 5517       | 5432       | 5348       | 5266       |
| 33 | 6264       | 6163       | 6064       | 5968       | 5874       | 5781       | 5691       | 5602       | 5515       | 5430       | 5347       | 5265       |
| 34 | 6262       | 6161       | 6062       | 5966       | 5872       | 5779       | 5689       | 5601       | 5514       | 5429       | 5345       | 5264       |
| 35 | 6260       | 6159       | 6061       | 5964       | 5870       | 5778       | 5688       | 5599       | 5512       | 5427       | 5344       | 5262       |
| 36 | 6259       | 6158       | 6059       | 5963       | 5869       | 5777       | 5686       | 5598       | 5511       | 5426       | 5343       | 5261       |
| 37 | 6257       | 6156       | 6058       | 5961       | 5867       | 5775       | 5685       | 5596       | 5510       | 5425       | 5341       | 5260       |
| 38 | 6255       | 6154       | 6056       | 5960       | 5866       | 5773       | 5683       | 5595       | 5508       | 5423       | 5340       | 5258       |
| 39 | 6254       | 6153       | 6055       | 5958       | 5864       | 5772       | 5682       | 5594       | 5507       | 5422       | 5339       | 5257       |
| 40 | 6252       | 6151       | 6053       | 5957       | 5862       | 5770       | 5680       | 5592       | 5505       | 5420       | 5337       | 5255       |
| 41 | 6250       | 6149       | 6051       | 5955       | 5861       | 5769       | 5679       | 5590       | 5504       | 5419       | 5336       | 5254       |
| 42 | 6248       | 6148       | 6050       | 5954       | 5860       | 5768       | 5677       | 5589       | 5503       | 5418       | 5335       | 5253       |
| 43 | 6247       | 6146       | 6048       | 5952       | 5858       | 5766       | 5676       | 5587       | 5501       | 5416       | 5333       | 5251       |
| 44 | 6245       | 6144       | 6046       | 5950       | 5856       | 5764       | 5674       | 5586       | 5500       | 5415       | 5332       | 5250       |
| 45 | 6243       | 6143       | 6045       | 5949       | 5855       | 5763       | 5673       | 5585       | 5498       | 5414       | 5331       | 5249       |
| 46 | 6241       | 6141       | 6043       | 5947       | 5853       | 5761       | 5671       | 5583       | 5497       | 5412       | 5329       | 5247       |
| 47 | 6240       | 6139       | 6041       | 5945       | 5852       | 5760       | 5670       | 5582       | 5495       | 5411       | 5328       | 5246       |
| 48 | 6238       | 6138       | 6040       | 5944       | 5850       | 5758       | 5669       | 5580       | 5494       | 5409       | 5326       | 5245       |
| 49 | 6236       | 6136       | 6038       | 5942       | 5849       | 5757       | 5667       | 5579       | 5492       | 5408       | 5325       | 5243       |
| 50 | 6235       | 6134       | 6037       | 5941       | 5847       | 5755       | 5665       | 5577       | 5491       | 5406       | 5323       | 5242       |
| 51 | 6233       | 6133       | 6035       | 5939       | 5846       | 5754       | 5664       | 5576       | 5490       | 5405       | 5322       | 5241       |
| 52 | 6231       | 6131       | 6033       | 5938       | 5844       | 5752       | 5662       | 5574       | 5488       | 5404       | 5321       | 5239       |
| 53 | 6230       | 6130       | 6032       | 5936       | 5842       | 5751       | 5661       | 5573       | 5487       | 5402       | 5319       | 5238       |
| 54 | 6228       | 6128       | 6030       | 5935       | 5841       | 5749       | 5660       | 5572       | 5486       | 5401       | 5318       | 5237       |
| 55 | 6226       | 6126       | 6028       | 5933       | 5839       | 5748       | 5658       | 5570       | 5484       | 5399       | 5317       | 5235       |
| 56 | 6225       | 6125       | 6027       | 5931       | 5838       | 5746       | 5656       | 5569       | 5482       | 5398       | 5315       | 5234       |
| 57 | 6223       | 6123       | 6025       | 5930       | 5836       | 5745       | 5655       | 5567       | 5481       | 5397       | 5314       | 5233       |
| 58 | 6221       | 6121       | 6024       | 5928       | 5835       | 5743       | 5654       | 5566       | 5480       | 5395       | 5312       | 5231       |
| 59 | 6220       | 6120       | 6022       | 5927       | 5833       | 5742       | 5652       | 5564       | 5478       | 5394       | 5311       | 5230       |
| 60 | 6218       | 6118       | 6021       | 5925       | 5832       | 5740       | 5651       | 5563       | 5477       | 5393       | 5310       | 5229       |



TABLE IX. PROPORTIONAL LOGARITHMS.

| S  | h<br>° 54' | h<br>° 55' | h<br>° 56' | h<br>° 57' | h<br>° 58' | h<br>° 59' | h<br>1° 0' | h<br>1° 1' | h<br>1° 2' | h<br>1° 3' | h<br>1° 4' | h<br>1° 5' |
|----|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 0  | 5229       | 5149       | 5071       | 4994       | 4918       | 4844       | 4771       | 4699       | 4629       | 4559       | 4491       | 4424       |
| 1  | 5227       | 5148       | 5069       | 4992       | 4917       | 4843       | 4770       | 4698       | 4627       | 4558       | 4490       | 4422       |
| 2  | 5226       | 5146       | 5068       | 4991       | 4916       | 4842       | 4769       | 4697       | 4626       | 4557       | 4489       | 4421       |
| 3  | 5225       | 5145       | 5067       | 4990       | 4915       | 4841       | 4768       | 4696       | 4625       | 4556       | 4488       | 4420       |
| 4  | 5223       | 5144       | 5065       | 4989       | 4913       | 4839       | 4766       | 4694       | 4624       | 4555       | 4486       | 4419       |
| 5  | 5222       | 5143       | 5064       | 4987       | 4912       | 4838       | 4765       | 4693       | 4623       | 4553       | 4485       | 4418       |
| 6  | 5221       | 5141       | 5063       | 4986       | 4911       | 4837       | 4764       | 4692       | 4622       | 4552       | 4484       | 4417       |
| 7  | 5219       | 5140       | 5062       | 4985       | 4910       | 4835       | 4763       | 4691       | 4620       | 4551       | 4483       | 4416       |
| 8  | 5218       | 5138       | 5060       | 4984       | 4908       | 4834       | 4761       | 4690       | 4619       | 4550       | 4482       | 4415       |
| 9  | 5217       | 5137       | 5059       | 4983       | 4907       | 4833       | 4760       | 4689       | 4618       | 4549       | 4481       | 4414       |
| 10 | 5215       | 5136       | 5058       | 4981       | 4906       | 4832       | 4759       | 4687       | 4617       | 4548       | 4479       | 4412       |
| 11 | 5214       | 5134       | 5056       | 4980       | 4905       | 4831       | 4758       | 4686       | 4616       | 4547       | 4478       | 4411       |
| 12 | 5213       | 5133       | 5055       | 4979       | 4903       | 4830       | 4757       | 4685       | 4615       | 4546       | 4477       | 4410       |
| 13 | 5211       | 5132       | 5054       | 4977       | 4902       | 4828       | 4755       | 4684       | 4613       | 4544       | 4476       | 4409       |
| 14 | 5210       | 5130       | 5053       | 4976       | 4901       | 4827       | 4754       | 4683       | 4612       | 4543       | 4475       | 4408       |
| 15 | 5209       | 5129       | 5051       | 4975       | 4900       | 4826       | 4753       | 4682       | 4611       | 4542       | 4474       | 4407       |
| 16 | 5207       | 5128       | 5050       | 4973       | 4898       | 4824       | 4752       | 4680       | 4610       | 4541       | 4473       | 4406       |
| 17 | 5206       | 5127       | 5049       | 4972       | 4897       | 4823       | 4751       | 4679       | 4609       | 4540       | 4472       | 4405       |
| 18 | 5205       | 5125       | 5048       | 4971       | 4896       | 4822       | 4750       | 4678       | 4608       | 4539       | 4471       | 4404       |
| 19 | 5203       | 5124       | 5046       | 4970       | 4895       | 4821       | 4748       | 4677       | 4606       | 4537       | 4469       | 4402       |
| 20 | 5202       | 5123       | 5045       | 4968       | 4893       | 4820       | 4747       | 4676       | 4605       | 4536       | 4468       | 4401       |
| 21 | 5201       | 5122       | 5044       | 4967       | 4892       | 4819       | 4746       | 4675       | 4604       | 4535       | 4467       | 4400       |
| 22 | 5199       | 5120       | 5042       | 4966       | 4891       | 4817       | 4745       | 4673       | 4603       | 4534       | 4466       | 4399       |
| 23 | 5198       | 5119       | 5041       | 4965       | 4890       | 4816       | 4743       | 4672       | 4602       | 4533       | 4465       | 4398       |
| 24 | 5197       | 5118       | 5040       | 4964       | 4889       | 4815       | 4742       | 4671       | 4601       | 4532       | 4464       | 4397       |
| 25 | 5195       | 5116       | 5038       | 4962       | 4887       | 4813       | 4741       | 4670       | 4600       | 4530       | 4463       | 4396       |
| 26 | 5194       | 5115       | 5037       | 4961       | 4886       | 4812       | 4740       | 4669       | 4598       | 4529       | 4461       | 4395       |
| 27 | 5193       | 5114       | 5036       | 4960       | 4885       | 4811       | 4739       | 4668       | 4597       | 4528       | 4460       | 4394       |
| 28 | 5191       | 5112       | 5035       | 4958       | 4883       | 4810       | 4737       | 4666       | 4596       | 4527       | 4459       | 4392       |
| 29 | 5190       | 5111       | 5033       | 4957       | 4882       | 4809       | 4736       | 4665       | 4595       | 4526       | 4458       | 4391       |
| 30 | 5189       | 5110       | 5032       | 4956       | 4881       | 4808       | 4735       | 4664       | 4594       | 4525       | 4457       | 4390       |
| 31 | 5187       | 5108       | 5031       | 4955       | 4880       | 4806       | 4734       | 4663       | 4593       | 4524       | 4456       | 4389       |
| 32 | 5186       | 5107       | 5029       | 4953       | 4878       | 4805       | 4733       | 4661       | 4591       | 4523       | 4455       | 4388       |
| 33 | 5185       | 5106       | 5028       | 4952       | 4877       | 4804       | 4732       | 4660       | 4590       | 4522       | 4454       | 4387       |
| 34 | 5183       | 5104       | 5027       | 4951       | 4876       | 4802       | 4730       | 4659       | 4589       | 4520       | 4452       | 4386       |
| 35 | 5182       | 5103       | 5026       | 4950       | 4875       | 4801       | 4729       | 4658       | 4588       | 4519       | 4451       | 4385       |
| 36 | 5181       | 5102       | 5025       | 4949       | 4874       | 4800       | 4728       | 4657       | 4587       | 4518       | 4450       | 4384       |
| 37 | 5179       | 5100       | 5023       | 4947       | 4872       | 4799       | 4727       | 4656       | 4586       | 4517       | 4449       | 4382       |
| 38 | 5178       | 5099       | 5022       | 4946       | 4871       | 4798       | 4725       | 4654       | 4585       | 4516       | 4448       | 4381       |
| 39 | 5177       | 5098       | 5021       | 4945       | 4870       | 4797       | 4724       | 4653       | 4584       | 4515       | 4447       | 4380       |
| 40 | 5175       | 5097       | 5019       | 4943       | 4869       | 4795       | 4723       | 4652       | 4582       | 4513       | 4446       | 4379       |
| 41 | 5174       | 5095       | 5018       | 4942       | 4867       | 4794       | 4722       | 4651       | 4581       | 4512       | 4445       | 4378       |
| 42 | 5173       | 5094       | 5017       | 4941       | 4866       | 4793       | 4721       | 4650       | 4580       | 4511       | 4444       | 4377       |
| 43 | 5171       | 5093       | 5015       | 4940       | 4865       | 4792       | 4719       | 4648       | 4579       | 4510       | 4442       | 4376       |
| 44 | 5170       | 5091       | 5014       | 4938       | 4864       | 4790       | 4718       | 4647       | 4578       | 4509       | 4441       | 4375       |
| 45 | 5169       | 5090       | 5013       | 4937       | 4863       | 4789       | 4717       | 4646       | 4577       | 4508       | 4440       | 4374       |
| 46 | 5167       | 5089       | 5012       | 4936       | 4861       | 4788       | 4716       | 4645       | 4575       | 4507       | 4439       | 4372       |
| 47 | 5166       | 5087       | 5010       | 4934       | 4860       | 4787       | 4715       | 4644       | 4574       | 4506       | 4438       | 4371       |
| 48 | 5165       | 5086       | 5009       | 4933       | 4859       | 4786       | 4714       | 4643       | 4573       | 4505       | 4437       | 4370       |
| 49 | 5163       | 5085       | 5008       | 4932       | 4858       | 4784       | 4712       | 4641       | 4572       | 4503       | 4436       | 4369       |
| 50 | 5162       | 5084       | 5006       | 4931       | 4856       | 4783       | 4711       | 4640       | 4571       | 4502       | 4435       | 4368       |
| 51 | 5161       | 5082       | 5005       | 4930       | 4855       | 4782       | 4710       | 4639       | 4570       | 4501       | 4434       | 4367       |
| 52 | 5159       | 5081       | 5004       | 4928       | 4854       | 4781       | 4709       | 4638       | 4568       | 4500       | 4432       | 4366       |
| 53 | 5158       | 5080       | 5003       | 4927       | 4853       | 4779       | 4708       | 4637       | 4567       | 4499       | 4431       | 4365       |
| 54 | 5157       | 5079       | 5002       | 4926       | 4852       | 4778       | 4707       | 4636       | 4566       | 4498       | 4430       | 4364       |
| 55 | 5155       | 5077       | 5000       | 4924       | 4850       | 4777       | 4705       | 4634       | 4565       | 4496       | 4429       | 4363       |
| 56 | 5154       | 5076       | 4999       | 4923       | 4849       | 4776       | 4704       | 4633       | 4564       | 4495       | 4428       | 4362       |
| 57 | 5153       | 5075       | 4998       | 4922       | 4848       | 4775       | 4703       | 4632       | 4563       | 4494       | 4427       | 4361       |
| 58 | 5152       | 5073       | 4996       | 4921       | 4846       | 4773       | 4702       | 4631       | 4561       | 4493       | 4426       | 4359       |
| 59 | 5150       | 5072       | 4995       | 4919       | 4845       | 4772       | 4700       | 4630       | 4560       | 4492       | 4425       | 4358       |
| 60 | 5149       | 5071       | 4994       | 4918       | 4844       | 4771       | 4699       | 4629       | 4559       | 4491       | 4424       | 4357       |

TABLE IX. PROPORTIONAL LOGARITHMS.

| S  | h<br>10 6' | h<br>10 7' | h<br>10 8' | h<br>10 9' | h<br>10 10' | h<br>10 11' | h<br>10 12' | h<br>10 13' | h<br>10 14' | h<br>10 15' | h<br>10 16' | h<br>10 17' |
|----|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 0  | 4357       | 4292       | 4228       | 4164       | 4102        | 4040        | 3979        | 3919        | 3860        | 3802        | 3745        | 3688        |
| 1  | 4356       | 4291       | 4226       | 4163       | 4101        | 4039        | 3978        | 3918        | 3859        | 3801        | 3744        | 3687        |
| 2  | 4355       | 4290       | 4225       | 4162       | 4100        | 4038        | 3977        | 3917        | 3858        | 3800        | 3743        | 3686        |
| 3  | 4354       | 4289       | 4224       | 4161       | 4099        | 4037        | 3976        | 3917        | 3857        | 3799        | 3742        | 3685        |
| 4  | 4353       | 4287       | 4223       | 4160       | 4098        | 4036        | 3975        | 3916        | 3856        | 3798        | 3741        | 3684        |
| 5  | 4352       | 4286       | 4222       | 4159       | 4097        | 4035        | 3974        | 3915        | 3855        | 3797        | 3740        | 3683        |
| 6  | 4351       | 4285       | 4221       | 4158       | 4096        | 4034        | 3973        | 3914        | 3854        | 3796        | 3739        | 3682        |
| 7  | 4349       | 4284       | 4220       | 4157       | 4094        | 4033        | 3972        | 3913        | 3854        | 3795        | 3738        | 3681        |
| 8  | 4348       | 4283       | 4219       | 4156       | 4093        | 4032        | 3971        | 3912        | 3853        | 3794        | 3737        | 3680        |
| 9  | 4347       | 4282       | 4218       | 4155       | 4092        | 4031        | 3970        | 3911        | 3852        | 3793        | 3736        | 3679        |
| 10 | 4346       | 4281       | 4217       | 4154       | 4091        | 4030        | 3969        | 3910        | 3851        | 3792        | 3735        | 3678        |
| 11 | 4345       | 4280       | 4216       | 4153       | 4090        | 4029        | 3968        | 3909        | 3850        | 3791        | 3734        | 3677        |
| 12 | 4344       | 4279       | 4215       | 4152       | 4089        | 4028        | 3967        | 3908        | 3849        | 3791        | 3733        | 3676        |
| 13 | 4343       | 4278       | 4214       | 4151       | 4088        | 4027        | 3966        | 3907        | 3848        | 3790        | 3732        | 3675        |
| 14 | 4342       | 4277       | 4213       | 4150       | 4087        | 4026        | 3965        | 3906        | 3847        | 3789        | 3731        | 3674        |
| 15 | 4341       | 4276       | 4212       | 4149       | 4086        | 4025        | 3964        | 3905        | 3846        | 3788        | 3730        | 3673        |
| 16 | 4340       | 4275       | 4211       | 4147       | 4085        | 4024        | 3963        | 3904        | 3845        | 3787        | 3729        | 3672        |
| 17 | 4339       | 4274       | 4210       | 4146       | 4084        | 4023        | 3962        | 3903        | 3844        | 3786        | 3728        | 3671        |
| 18 | 4338       | 4273       | 4209       | 4145       | 4083        | 4022        | 3961        | 3902        | 3843        | 3785        | 3727        | 3670        |
| 19 | 4336       | 4271       | 4207       | 4144       | 4082        | 4021        | 3960        | 3901        | 3842        | 3784        | 3726        | 3669        |
| 20 | 4335       | 4270       | 4206       | 4143       | 4081        | 4020        | 3959        | 3900        | 3841        | 3783        | 3725        | 3668        |
| 21 | 4334       | 4269       | 4205       | 4142       | 4080        | 4019        | 3958        | 3899        | 3840        | 3782        | 3725        | 3667        |
| 22 | 4333       | 4268       | 4204       | 4141       | 4079        | 4018        | 3957        | 3898        | 3839        | 3781        | 3724        | 3666        |
| 23 | 4332       | 4267       | 4203       | 4140       | 4078        | 4017        | 3956        | 3897        | 3838        | 3780        | 3723        | 3665        |
| 24 | 4331       | 4266       | 4202       | 4139       | 4077        | 4016        | 3955        | 3896        | 3837        | 3779        | 3722        | 3664        |
| 25 | 4330       | 4265       | 4201       | 4138       | 4076        | 4015        | 3954        | 3895        | 3836        | 3778        | 3721        | 3663        |
| 26 | 4329       | 4264       | 4200       | 4137       | 4075        | 4014        | 3953        | 3894        | 3835        | 3777        | 3720        | 3662        |
| 27 | 4328       | 4263       | 4199       | 4136       | 4074        | 4013        | 3952        | 3893        | 3834        | 3776        | 3719        | 3661        |
| 28 | 4327       | 4262       | 4198       | 4135       | 4073        | 4012        | 3951        | 3892        | 3833        | 3775        | 3718        | 3660        |
| 29 | 4326       | 4261       | 4197       | 4134       | 4072        | 4011        | 3950        | 3891        | 3832        | 3774        | 3717        | 3659        |
| 30 | 4325       | 4260       | 4196       | 4133       | 4071        | 4010        | 3949        | 3890        | 3831        | 3773        | 3716        | 3658        |
| 31 | 4323       | 4258       | 4195       | 4132       | 4070        | 4009        | 3948        | 3889        | 3830        | 3772        | 3715        | 3657        |
| 32 | 4322       | 4257       | 4194       | 4131       | 4069        | 4008        | 3947        | 3888        | 3829        | 3771        | 3714        | 3656        |
| 33 | 4321       | 4256       | 4193       | 4130       | 4068        | 4007        | 3946        | 3887        | 3828        | 3770        | 3713        | 3655        |
| 34 | 4320       | 4255       | 4192       | 4129       | 4067        | 4006        | 3945        | 3886        | 3827        | 3769        | 3712        | 3654        |
| 35 | 4319       | 4254       | 4191       | 4128       | 4066        | 4005        | 3944        | 3885        | 3826        | 3768        | 3711        | 3653        |
| 36 | 4318       | 4253       | 4189       | 4127       | 4065        | 4004        | 3943        | 3884        | 3825        | 3768        | 3710        | 3652        |
| 37 | 4317       | 4252       | 4188       | 4126       | 4064        | 4003        | 3942        | 3883        | 3824        | 3767        | 3709        | 3651        |
| 38 | 4316       | 4251       | 4187       | 4125       | 4063        | 4002        | 3941        | 3882        | 3823        | 3766        | 3708        | 3650        |
| 39 | 4315       | 4250       | 4186       | 4124       | 4062        | 4001        | 3940        | 3881        | 3822        | 3765        | 3708        | 3649        |
| 40 | 4313       | 4249       | 4185       | 4122       | 4061        | 4000        | 3939        | 3880        | 3821        | 3764        | 3707        | 3648        |
| 41 | 4312       | 4248       | 4184       | 4121       | 4060        | 3999        | 3938        | 3879        | 3820        | 3763        | 3706        | 3647        |
| 42 | 4311       | 4247       | 4183       | 4120       | 4059        | 3998        | 3937        | 3878        | 3819        | 3762        | 3705        | 3646        |
| 43 | 4310       | 4246       | 4182       | 4119       | 4057        | 3997        | 3936        | 3877        | 3818        | 3761        | 3704        | 3645        |
| 44 | 4309       | 4245       | 4181       | 4118       | 4056        | 3996        | 3935        | 3876        | 3817        | 3760        | 3703        | 3644        |
| 45 | 4308       | 4244       | 4180       | 4117       | 4055        | 3995        | 3934        | 3875        | 3816        | 3759        | 3702        | 3643        |
| 46 | 4307       | 4242       | 4179       | 4116       | 4054        | 3993        | 3933        | 3874        | 3815        | 3758        | 3701        | 3642        |
| 47 | 4306       | 4241       | 4178       | 4115       | 4053        | 3992        | 3932        | 3873        | 3814        | 3757        | 3700        | 3641        |
| 48 | 4305       | 4240       | 4177       | 4114       | 4052        | 3991        | 3931        | 3872        | 3813        | 3756        | 3699        | 3640        |
| 49 | 4304       | 4239       | 4176       | 4113       | 4051        | 3990        | 3930        | 3871        | 3812        | 3755        | 3698        | 3639        |
| 50 | 4303       | 4238       | 4175       | 4112       | 4050        | 3989        | 3929        | 3870        | 3811        | 3754        | 3697        | 3638        |
| 51 | 4302       | 4237       | 4174       | 4111       | 4049        | 3988        | 3928        | 3869        | 3810        | 3753        | 3696        | 3637        |
| 52 | 4300       | 4236       | 4173       | 4110       | 4048        | 3987        | 3927        | 3868        | 3809        | 3752        | 3695        | 3636        |
| 53 | 4299       | 4235       | 4172       | 4109       | 4047        | 3986        | 3926        | 3867        | 3808        | 3751        | 3694        | 3635        |
| 54 | 4298       | 4234       | 4171       | 4108       | 4046        | 3985        | 3925        | 3866        | 3807        | 3750        | 3693        | 3634        |
| 55 | 4297       | 4233       | 4169       | 4107       | 4045        | 3984        | 3924        | 3865        | 3806        | 3749        | 3692        | 3633        |
| 56 | 4296       | 4232       | 4168       | 4106       | 4044        | 3983        | 3923        | 3864        | 3805        | 3748        | 3691        | 3632        |
| 57 | 4295       | 4231       | 4167       | 4105       | 4043        | 3982        | 3922        | 3863        | 3804        | 3747        | 3690        | 3631        |
| 58 | 4294       | 4230       | 4166       | 4104       | 4042        | 3981        | 3921        | 3862        | 3803        | 3746        | 3689        | 3630        |
| 59 | 4293       | 4229       | 4165       | 4103       | 4041        | 3980        | 3920        | 3861        | 3802        | 3745        | 3688        | 3629        |
| 60 | 4292       | 4228       | 4164       | 4102       | 4040        | 3979        | 3919        | 3860        | 3801        | 3744        | 3687        | 3628        |

TABLE IX. PROPORTIONAL LOGARITHMS.

| S  | $10^{18}$ | $10^{19}$ | $10^{20}$ | $10^{21}$ | $10^{22}$ | $10^{23}$ | $10^{24}$ | $10^{25}$ | $10^{26}$ | $10^{27}$ | $10^{28}$ | $10^{29}$ |
|----|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 0  | 3632      | 3576      | 3522      | 3468      | 3415      | 3362      | 3310      | 3259      | 3208      | 3158      | 3108      | 3059      |
| 1  | 3631      | 3575      | 3521      | 3467      | 3414      | 3361      | 3309      | 3258      | 3207      | 3157      | 3107      | 3058      |
| 2  | 3630      | 3574      | 3520      | 3466      | 3413      | 3360      | 3308      | 3257      | 3206      | 3156      | 3106      | 3057      |
| 3  | 3629      | 3573      | 3519      | 3465      | 3412      | 3359      | 3307      | 3256      | 3205      | 3155      | 3105      | 3056      |
| 4  | 3628      | 3572      | 3518      | 3464      | 3411      | 3358      | 3306      | 3255      | 3204      | 3154      | 3104      | 3055      |
| 5  | 3627      | 3571      | 3517      | 3463      | 3410      | 3357      | 3305      | 3254      | 3203      | 3153      | 3103      | 3054      |
| 6  | 3626      | 3570      | 3516      | 3462      | 3409      | 3356      | 3304      | 3253      | 3202      | 3152      | 3102      | 3053      |
| 7  | 3625      | 3569      | 3515      | 3461      | 3407      | 3355      | 3303      | 3252      | 3201      | 3151      | 3101      | 3052      |
| 8  | 3624      | 3568      | 3514      | 3460      | 3406      | 3354      | 3302      | 3251      | 3200      | 3150      | 3100      | 3051      |
| 9  | 3623      | 3567      | 3513      | 3459      | 3405      | 3353      | 3301      | 3250      | 3199      | 3149      | 3100      | 3051      |
| 10 | 3622      | 3566      | 3512      | 3458      | 3405      | 3352      | 3300      | 3249      | 3198      | 3148      | 3099      | 3050      |
| 11 | 3621      | 3565      | 3511      | 3457      | 3404      | 3351      | 3300      | 3248      | 3198      | 3148      | 3098      | 3049      |
| 12 | 3620      | 3564      | 3510      | 3456      | 3403      | 3351      | 3299      | 3247      | 3197      | 3147      | 3097      | 3048      |
| 13 | 3619      | 3563      | 3509      | 3455      | 3402      | 3350      | 3298      | 3247      | 3196      | 3146      | 3096      | 3047      |
| 14 | 3618      | 3562      | 3508      | 3454      | 3401      | 3349      | 3297      | 3246      | 3195      | 3145      | 3095      | 3046      |
| 15 | 3617      | 3561      | 3507      | 3453      | 3400      | 3348      | 3296      | 3245      | 3194      | 3144      | 3094      | 3045      |
| 16 | 3616      | 3560      | 3506      | 3452      | 3399      | 3347      | 3295      | 3244      | 3193      | 3143      | 3093      | 3044      |
| 17 | 3615      | 3559      | 3505      | 3451      | 3398      | 3346      | 3294      | 3243      | 3192      | 3142      | 3092      | 3043      |
| 18 | 3614      | 3558      | 3504      | 3450      | 3397      | 3345      | 3293      | 3242      | 3191      | 3141      | 3091      | 3042      |
| 19 | 3613      | 3557      | 3503      | 3449      | 3396      | 3344      | 3292      | 3241      | 3190      | 3140      | 3090      | 3041      |
| 20 | 3612      | 3556      | 3502      | 3448      | 3395      | 3343      | 3291      | 3240      | 3189      | 3139      | 3089      | 3040      |
| 21 | 3611      | 3555      | 3501      | 3447      | 3394      | 3342      | 3290      | 3239      | 3188      | 3138      | 3088      | 3039      |
| 22 | 3610      | 3554      | 3500      | 3446      | 3393      | 3341      | 3289      | 3238      | 3187      | 3137      | 3087      | 3038      |
| 23 | 3609      | 3553      | 3499      | 3445      | 3392      | 3340      | 3288      | 3237      | 3186      | 3136      | 3086      | 3037      |
| 24 | 3608      | 3552      | 3498      | 3444      | 3391      | 3339      | 3287      | 3236      | 3185      | 3135      | 3085      | 3036      |
| 25 | 3607      | 3551      | 3497      | 3443      | 3390      | 3338      | 3286      | 3235      | 3184      | 3134      | 3084      | 3035      |
| 26 | 3606      | 3550      | 3496      | 3442      | 3389      | 3337      | 3285      | 3234      | 3183      | 3133      | 3083      | 3034      |
| 27 | 3605      | 3549      | 3495      | 3441      | 3388      | 3336      | 3284      | 3233      | 3182      | 3132      | 3082      | 3033      |
| 28 | 3604      | 3548      | 3494      | 3440      | 3387      | 3335      | 3283      | 3232      | 3181      | 3131      | 3081      | 3032      |
| 29 | 3603      | 3547      | 3493      | 3439      | 3386      | 3334      | 3282      | 3231      | 3180      | 3130      | 3080      | 3031      |
| 30 | 3602      | 3546      | 3492      | 3438      | 3385      | 3333      | 3281      | 3230      | 3179      | 3129      | 3079      | 3030      |
| 31 | 3601      | 3545      | 3491      | 3437      | 3384      | 3332      | 3280      | 3229      | 3178      | 3128      | 3078      | 3029      |
| 32 | 3600      | 3544      | 3490      | 3436      | 3383      | 3331      | 3279      | 3228      | 3177      | 3127      | 3077      | 3028      |
| 33 | 3599      | 3543      | 3489      | 3435      | 3382      | 3330      | 3278      | 3227      | 3176      | 3126      | 3076      | 3027      |
| 34 | 3598      | 3542      | 3488      | 3434      | 3381      | 3329      | 3277      | 3226      | 3175      | 3125      | 3075      | 3026      |
| 35 | 3597      | 3541      | 3487      | 3433      | 3380      | 3328      | 3276      | 3225      | 3174      | 3124      | 3074      | 3025      |
| 36 | 3596      | 3540      | 3486      | 3432      | 3379      | 3327      | 3275      | 3224      | 3173      | 3123      | 3073      | 3024      |
| 37 | 3595      | 3539      | 3485      | 3431      | 3378      | 3326      | 3274      | 3223      | 3172      | 3122      | 3072      | 3023      |
| 38 | 3594      | 3538      | 3484      | 3430      | 3377      | 3325      | 3273      | 3222      | 3171      | 3121      | 3071      | 3022      |
| 39 | 3593      | 3537      | 3483      | 3429      | 3376      | 3324      | 3272      | 3221      | 3170      | 3120      | 3070      | 3021      |
| 40 | 3592      | 3536      | 3482      | 3428      | 3375      | 3323      | 3271      | 3220      | 3169      | 3119      | 3069      | 3020      |
| 41 | 3591      | 3535      | 3481      | 3427      | 3374      | 3322      | 3270      | 3219      | 3168      | 3118      | 3068      | 3019      |
| 42 | 3590      | 3534      | 3480      | 3426      | 3373      | 3321      | 3269      | 3218      | 3167      | 3117      | 3067      | 3018      |
| 43 | 3589      | 3533      | 3479      | 3425      | 3372      | 3320      | 3268      | 3217      | 3166      | 3116      | 3066      | 3017      |
| 44 | 3588      | 3532      | 3478      | 3424      | 3371      | 3319      | 3267      | 3216      | 3165      | 3115      | 3065      | 3016      |
| 45 | 3587      | 3531      | 3477      | 3423      | 3370      | 3318      | 3266      | 3215      | 3164      | 3114      | 3064      | 3015      |
| 46 | 3586      | 3530      | 3476      | 3422      | 3369      | 3317      | 3265      | 3214      | 3163      | 3113      | 3063      | 3014      |
| 47 | 3585      | 3529      | 3475      | 3421      | 3368      | 3316      | 3264      | 3213      | 3162      | 3112      | 3062      | 3013      |
| 48 | 3584      | 3528      | 3474      | 3420      | 3367      | 3315      | 3263      | 3212      | 3161      | 3111      | 3061      | 3012      |
| 49 | 3583      | 3527      | 3473      | 3419      | 3366      | 3314      | 3262      | 3211      | 3160      | 3110      | 3060      | 3011      |
| 50 | 3582      | 3526      | 3472      | 3418      | 3365      | 3313      | 3261      | 3210      | 3159      | 3109      | 3059      | 3010      |
| 51 | 3581      | 3525      | 3471      | 3417      | 3364      | 3312      | 3260      | 3209      | 3158      | 3108      | 3058      | 3009      |
| 52 | 3580      | 3524      | 3470      | 3416      | 3363      | 3311      | 3259      | 3208      | 3157      | 3107      | 3057      | 3008      |
| 53 | 3579      | 3523      | 3469      | 3415      | 3362      | 3310      | 3258      | 3207      | 3156      | 3106      | 3056      | 3007      |
| 54 | 3578      | 3522      | 3468      | 3414      | 3361      | 3309      | 3257      | 3206      | 3155      | 3105      | 3055      | 3006      |
| 55 | 3577      | 3521      | 3467      | 3413      | 3360      | 3308      | 3256      | 3205      | 3154      | 3104      | 3054      | 3005      |
| 56 | 3576      | 3520      | 3466      | 3412      | 3359      | 3307      | 3255      | 3204      | 3153      | 3103      | 3053      | 3004      |
| 57 | 3575      | 3519      | 3465      | 3411      | 3358      | 3306      | 3254      | 3203      | 3152      | 3102      | 3052      | 3003      |
| 58 | 3574      | 3518      | 3464      | 3410      | 3357      | 3305      | 3253      | 3202      | 3151      | 3101      | 3051      | 3002      |
| 59 | 3573      | 3517      | 3463      | 3409      | 3356      | 3304      | 3252      | 3201      | 3150      | 3100      | 3050      | 3001      |
| 60 | 3572      | 3516      | 3462      | 3408      | 3355      | 3303      | 3251      | 3200      | 3149      | 3099      | 3049      | 3000      |



TABLE IX. PROPORTIONAL LOGARITHMS.

| S  | h<br>1° 30' | h<br>1° 31' | h<br>1° 32' | h<br>1° 33' | h<br>1° 34' | h<br>1° 35' | h<br>1° 36' | h<br>1° 37' | h<br>1° 38' | h<br>1° 39' | h<br>1° 40' | h<br>1° 41' |
|----|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 0  | 3010        | 2962        | 2915        | 2868        | 2821        | 2775        | 2730        | 2685        | 2640        | 2596        | 2553        | 2510        |
| 1  | 3009        | 2961        | 2914        | 2867        | 2821        | 2775        | 2729        | 2684        | 2640        | 2596        | 2552        | 2509        |
| 2  | 3009        | 2961        | 2913        | 2866        | 2820        | 2774        | 2728        | 2683        | 2639        | 2595        | 2551        | 2508        |
| 3  | 3008        | 2960        | 2912        | 2866        | 2819        | 2773        | 2728        | 2683        | 2638        | 2594        | 2551        | 2507        |
| 4  | 3007        | 2959        | 2912        | 2865        | 2818        | 2772        | 2727        | 2682        | 2637        | 2593        | 2550        | 2507        |
| 5  | 3006        | 2958        | 2911        | 2864        | 2818        | 2772        | 2726        | 2681        | 2637        | 2593        | 2549        | 2506        |
| 6  | 3005        | 2958        | 2910        | 2863        | 2817        | 2771        | 2725        | 2681        | 2636        | 2592        | 2548        | 2505        |
| 7  | 3005        | 2957        | 2909        | 2862        | 2816        | 2770        | 2725        | 2680        | 2635        | 2591        | 2548        | 2504        |
| 8  | 3004        | 2956        | 2908        | 2862        | 2815        | 2769        | 2724        | 2679        | 2634        | 2590        | 2547        | 2504        |
| 9  | 3003        | 2955        | 2908        | 2861        | 2815        | 2769        | 2723        | 2678        | 2634        | 2590        | 2546        | 2503        |
| 10 | 3002        | 2954        | 2907        | 2860        | 2814        | 2768        | 2722        | 2678        | 2633        | 2589        | 2545        | 2502        |
| 11 | 3001        | 2954        | 2906        | 2859        | 2813        | 2767        | 2722        | 2677        | 2632        | 2588        | 2545        | 2502        |
| 12 | 3001        | 2953        | 2905        | 2859        | 2812        | 2766        | 2721        | 2676        | 2632        | 2588        | 2544        | 2501        |
| 13 | 3000        | 2952        | 2905        | 2858        | 2811        | 2766        | 2720        | 2675        | 2631        | 2587        | 2543        | 2500        |
| 14 | 2999        | 2951        | 2904        | 2857        | 2811        | 2765        | 2719        | 2675        | 2630        | 2586        | 2543        | 2499        |
| 15 | 2998        | 2950        | 2903        | 2856        | 2810        | 2764        | 2719        | 2674        | 2629        | 2585        | 2542        | 2499        |
| 16 | 2997        | 2950        | 2902        | 2855        | 2809        | 2763        | 2718        | 2673        | 2629        | 2585        | 2541        | 2498        |
| 17 | 2997        | 2949        | 2901        | 2855        | 2808        | 2762        | 2717        | 2672        | 2628        | 2584        | 2540        | 2497        |
| 18 | 2996        | 2948        | 2901        | 2854        | 2808        | 2762        | 2716        | 2672        | 2627        | 2583        | 2540        | 2497        |
| 19 | 2995        | 2947        | 2900        | 2853        | 2807        | 2761        | 2716        | 2671        | 2626        | 2582        | 2539        | 2496        |
| 20 | 2994        | 2946        | 2899        | 2852        | 2806        | 2760        | 2715        | 2670        | 2626        | 2582        | 2538        | 2495        |
| 21 | 2993        | 2946        | 2898        | 2852        | 2805        | 2760        | 2714        | 2669        | 2625        | 2581        | 2538        | 2494        |
| 22 | 2993        | 2945        | 2898        | 2851        | 2804        | 2759        | 2713        | 2669        | 2624        | 2580        | 2537        | 2494        |
| 23 | 2992        | 2944        | 2897        | 2850        | 2804        | 2758        | 2713        | 2668        | 2623        | 2580        | 2536        | 2493        |
| 24 | 2991        | 2943        | 2896        | 2849        | 2803        | 2757        | 2712        | 2667        | 2623        | 2579        | 2535        | 2492        |
| 25 | 2990        | 2942        | 2895        | 2848        | 2802        | 2756        | 2711        | 2666        | 2622        | 2578        | 2535        | 2492        |
| 26 | 2989        | 2942        | 2894        | 2848        | 2801        | 2756        | 2710        | 2666        | 2621        | 2577        | 2534        | 2491        |
| 27 | 2989        | 2941        | 2894        | 2847        | 2801        | 2755        | 2710        | 2665        | 2621        | 2577        | 2533        | 2490        |
| 28 | 2988        | 2940        | 2893        | 2846        | 2800        | 2754        | 2709        | 2664        | 2620        | 2576        | 2532        | 2489        |
| 29 | 2987        | 2939        | 2892        | 2845        | 2799        | 2753        | 2708        | 2663        | 2619        | 2575        | 2532        | 2489        |
| 30 | 2986        | 2939        | 2891        | 2845        | 2798        | 2753        | 2707        | 2663        | 2618        | 2574        | 2531        | 2488        |
| 31 | 2985        | 2938        | 2890        | 2844        | 2798        | 2752        | 2707        | 2662        | 2618        | 2574        | 2530        | 2487        |
| 32 | 2985        | 2937        | 2890        | 2843        | 2797        | 2751        | 2706        | 2661        | 2617        | 2573        | 2530        | 2487        |
| 33 | 2984        | 2936        | 2889        | 2842        | 2796        | 2750        | 2705        | 2660        | 2616        | 2572        | 2529        | 2486        |
| 34 | 2983        | 2935        | 2888        | 2841        | 2795        | 2750        | 2704        | 2660        | 2615        | 2572        | 2528        | 2485        |
| 35 | 2982        | 2934        | 2887        | 2841        | 2795        | 2749        | 2704        | 2659        | 2615        | 2571        | 2527        | 2484        |
| 36 | 2981        | 2934        | 2887        | 2840        | 2794        | 2748        | 2703        | 2658        | 2614        | 2570        | 2527        | 2484        |
| 37 | 2981        | 2933        | 2886        | 2839        | 2793        | 2747        | 2702        | 2657        | 2613        | 2569        | 2526        | 2483        |
| 38 | 2980        | 2932        | 2885        | 2838        | 2792        | 2747        | 2701        | 2657        | 2612        | 2569        | 2525        | 2482        |
| 39 | 2979        | 2931        | 2884        | 2838        | 2792        | 2746        | 2701        | 2656        | 2612        | 2568        | 2525        | 2482        |
| 40 | 2978        | 2931        | 2883        | 2837        | 2791        | 2745        | 2600        | 2655        | 2611        | 2567        | 2524        | 2481        |
| 41 | 2977        | 2930        | 2883        | 2836        | 2790        | 2744        | 2699        | 2654        | 2610        | 2566        | 2523        | 2480        |
| 42 | 2977        | 2929        | 2882        | 2835        | 2789        | 2744        | 2698        | 2654        | 2610        | 2566        | 2522        | 2480        |
| 43 | 2976        | 2928        | 2881        | 2834        | 2788        | 2743        | 2698        | 2653        | 2609        | 2565        | 2522        | 2479        |
| 44 | 2975        | 2927        | 2880        | 2834        | 2788        | 2742        | 2697        | 2652        | 2608        | 2564        | 2521        | 2478        |
| 45 | 2974        | 2927        | 2880        | 2833        | 2787        | 2741        | 2696        | 2652        | 2607        | 2564        | 2520        | 2477        |
| 46 | 2973        | 2926        | 2879        | 2832        | 2786        | 2741        | 2695        | 2651        | 2607        | 2563        | 2520        | 2477        |
| 47 | 2973        | 2925        | 2878        | 2831        | 2785        | 2740        | 2695        | 2650        | 2606        | 2562        | 2519        | 2476        |
| 48 | 2972        | 2924        | 2877        | 2831        | 2785        | 2739        | 2694        | 2649        | 2605        | 2561        | 2518        | 2475        |
| 49 | 2971        | 2923        | 2876        | 2830        | 2784        | 2738        | 2693        | 2649        | 2604        | 2561        | 2517        | 2474        |
| 50 | 2970        | 2923        | 2876        | 2829        | 2783        | 2737        | 2692        | 2648        | 2604        | 2560        | 2517        | 2474        |
| 51 | 2969        | 2922        | 2875        | 2828        | 2782        | 2737        | 2692        | 2647        | 2603        | 2559        | 2516        | 2473        |
| 52 | 2969        | 2921        | 2874        | 2828        | 2782        | 2736        | 2691        | 2646        | 2602        | 2558        | 2515        | 2472        |
| 53 | 2968        | 2920        | 2873        | 2827        | 2781        | 2735        | 2690        | 2646        | 2601        | 2558        | 2514        | 2472        |
| 54 | 2967        | 2920        | 2873        | 2826        | 2780        | 2735        | 2689        | 2645        | 2601        | 2557        | 2514        | 2471        |
| 55 | 2966        | 2919        | 2872        | 2825        | 2779        | 2734        | 2689        | 2644        | 2600        | 2556        | 2513        | 2470        |
| 56 | 2965        | 2918        | 2871        | 2824        | 2778        | 2733        | 2688        | 2643        | 2599        | 2556        | 2512        | 2470        |
| 57 | 2965        | 2917        | 2870        | 2824        | 2778        | 2732        | 2687        | 2643        | 2599        | 2555        | 2512        | 2469        |
| 58 | 2964        | 2916        | 2869        | 2823        | 2777        | 2731        | 2686        | 2642        | 2598        | 2554        | 2511        | 2468        |
| 59 | 2963        | 2916        | 2869        | 2822        | 2776        | 2731        | 2686        | 2641        | 2597        | 2553        | 2510        | 2467        |
| 60 | 2962        | 2915        | 2868        | 2821        | 2775        | 2730        | 2685        | 2640        | 2596        | 2553        | 2510        | 2467        |

TABLE IX. PROPORTIONAL LOGARITHMS.

| S  | h<br>1° 42' | h<br>1° 43' | h<br>1° 44' | h<br>1° 45' | h<br>1° 46' | h<br>1° 47' | h<br>1° 48' | h<br>1° 49' | h<br>1° 50' | h<br>1° 51' | h<br>1° 52' | h<br>1° 53' |
|----|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 0  | 2467        | 2424        | 2382        | 2341        | 2300        | 2259        | 2218        | 2178        | 2139        | 2099        | 2061        | 2022        |
| 1  | 2456        | 2424        | 2382        | 2340        | 2299        | 2258        | 2218        | 2178        | 2138        | 2099        | 2060        | 2021        |
| 2  | 2465        | 2423        | 2381        | 2339        | 2298        | 2257        | 2217        | 2177        | 2137        | 2098        | 2059        | 2020        |
| 3  | 2465        | 2422        | 2380        | 2339        | 2298        | 2257        | 2216        | 2176        | 2137        | 2098        | 2059        | 2020        |
| 4  | 2464        | 2421        | 2380        | 2338        | 2297        | 2256        | 2216        | 2176        | 2136        | 2097        | 2058        | 2019        |
| 5  | 2463        | 2421        | 2379        | 2337        | 2296        | 2255        | 2215        | 2175        | 2135        | 2096        | 2057        | 2018        |
| 6  | 2462        | 2420        | 2378        | 2337        | 2296        | 2255        | 2214        | 2174        | 2135        | 2096        | 2057        | 2018        |
| 7  | 2462        | 2419        | 2378        | 2336        | 2295        | 2254        | 2214        | 2174        | 2134        | 2095        | 2056        | 2017        |
| 8  | 2461        | 2419        | 2377        | 2335        | 2294        | 2253        | 2213        | 2173        | 2133        | 2094        | 2055        | 2017        |
| 9  | 2460        | 2418        | 2376        | 2335        | 2294        | 2253        | 2212        | 2172        | 2133        | 2094        | 2055        | 2016        |
| 10 | 2460        | 2417        | 2375        | 2334        | 2293        | 2252        | 2212        | 2172        | 2132        | 2093        | 2054        | 2016        |
| 11 | 2459        | 2417        | 2375        | 2333        | 2292        | 2251        | 2211        | 2171        | 2132        | 2092        | 2053        | 2015        |
| 12 | 2458        | 2416        | 2374        | 2333        | 2291        | 2251        | 2210        | 2170        | 2131        | 2092        | 2053        | 2014        |
| 13 | 2457        | 2415        | 2373        | 2332        | 2291        | 2250        | 2210        | 2170        | 2130        | 2091        | 2052        | 2014        |
| 14 | 2457        | 2414        | 2373        | 2331        | 2290        | 2249        | 2209        | 2169        | 2130        | 2090        | 2051        | 2013        |
| 15 | 2456        | 2414        | 2372        | 2331        | 2289        | 2249        | 2208        | 2169        | 2129        | 2090        | 2051        | 2013        |
| 16 | 2455        | 2413        | 2371        | 2330        | 2289        | 2248        | 2208        | 2168        | 2128        | 2089        | 2050        | 2012        |
| 17 | 2455        | 2412        | 2371        | 2329        | 2288        | 2247        | 2207        | 2167        | 2128        | 2088        | 2050        | 2011        |
| 18 | 2454        | 2412        | 2370        | 2328        | 2287        | 2247        | 2206        | 2167        | 2127        | 2088        | 2049        | 2010        |
| 19 | 2453        | 2411        | 2369        | 2328        | 2287        | 2246        | 2206        | 2166        | 2126        | 2087        | 2048        | 2010        |
| 20 | 2452        | 2410        | 2368        | 2327        | 2286        | 2245        | 2205        | 2165        | 2126        | 2086        | 2048        | 2009        |
| 21 | 2452        | 2410        | 2368        | 2326        | 2285        | 2245        | 2204        | 2165        | 2125        | 2086        | 2047        | 2009        |
| 22 | 2451        | 2409        | 2367        | 2326        | 2285        | 2244        | 2204        | 2164        | 2124        | 2085        | 2046        | 2008        |
| 23 | 2450        | 2408        | 2366        | 2325        | 2284        | 2243        | 2203        | 2163        | 2124        | 2084        | 2046        | 2007        |
| 24 | 2450        | 2408        | 2366        | 2324        | 2283        | 2243        | 2202        | 2163        | 2123        | 2084        | 2045        | 2007        |
| 25 | 2449        | 2407        | 2365        | 2324        | 2283        | 2242        | 2202        | 2162        | 2122        | 2083        | 2044        | 2006        |
| 26 | 2448        | 2406        | 2364        | 2323        | 2282        | 2241        | 2201        | 2161        | 2122        | 2083        | 2044        | 2006        |
| 27 | 2448        | 2405        | 2364        | 2322        | 2281        | 2241        | 2200        | 2161        | 2121        | 2082        | 2043        | 2005        |
| 28 | 2447        | 2405        | 2363        | 2322        | 2281        | 2240        | 2200        | 2160        | 2120        | 2081        | 2042        | 2005        |
| 29 | 2446        | 2404        | 2362        | 2321        | 2280        | 2239        | 2199        | 2159        | 2120        | 2081        | 2042        | 2005        |
| 30 | 2445        | 2403        | 2362        | 2320        | 2279        | 2239        | 2198        | 2159        | 2119        | 2080        | 2041        | 2005        |
| 31 | 2445        | 2403        | 2361        | 2319        | 2279        | 2238        | 2198        | 2158        | 2118        | 2079        | 2041        | 2005        |
| 32 | 2444        | 2402        | 2360        | 2319        | 2278        | 2237        | 2197        | 2157        | 2118        | 2079        | 2040        | 2005        |
| 33 | 2443        | 2401        | 2359        | 2318        | 2277        | 2237        | 2196        | 2157        | 2117        | 2078        | 2039        | 2005        |
| 34 | 2443        | 2400        | 2359        | 2317        | 2276        | 2236        | 2196        | 2156        | 2116        | 2077        | 2039        | 2005        |
| 35 | 2442        | 2400        | 2358        | 2317        | 2276        | 2235        | 2195        | 2155        | 2116        | 2077        | 2038        | 2005        |
| 36 | 2441        | 2399        | 2357        | 2316        | 2275        | 2235        | 2194        | 2155        | 2115        | 2076        | 2037        | 1999        |
| 37 | 2440        | 2398        | 2357        | 2315        | 2274        | 2234        | 2194        | 2154        | 2114        | 2075        | 2037        | 1999        |
| 38 | 2440        | 2398        | 2356        | 2315        | 2274        | 2233        | 2193        | 2153        | 2114        | 2075        | 2036        | 1999        |
| 39 | 2439        | 2397        | 2355        | 2314        | 2273        | 2233        | 2192        | 2153        | 2113        | 2074        | 2035        | 1999        |
| 40 | 2438        | 2396        | 2355        | 2313        | 2272        | 2232        | 2192        | 2152        | 2113        | 2073        | 2035        | 1999        |
| 41 | 2438        | 2396        | 2354        | 2313        | 2272        | 2231        | 2191        | 2151        | 2112        | 2073        | 2034        | 1999        |
| 42 | 2437        | 2395        | 2353        | 2312        | 2271        | 2231        | 2190        | 2151        | 2111        | 2072        | 2033        | 1999        |
| 43 | 2436        | 2394        | 2353        | 2311        | 2270        | 2230        | 2190        | 2150        | 2111        | 2071        | 2033        | 1999        |
| 44 | 2436        | 2394        | 2352        | 2311        | 2270        | 2229        | 2189        | 2149        | 2110        | 2071        | 2032        | 1999        |
| 45 | 2435        | 2393        | 2351        | 2310        | 2269        | 2229        | 2188        | 2149        | 2109        | 2070        | 2032        | 1999        |
| 46 | 2434        | 2392        | 2350        | 2309        | 2268        | 2228        | 2188        | 2148        | 2109        | 2070        | 2031        | 1999        |
| 47 | 2433        | 2391        | 2350        | 2308        | 2268        | 2227        | 2187        | 2147        | 2108        | 2069        | 2030        | 1999        |
| 48 | 2433        | 2391        | 2349        | 2308        | 2267        | 2227        | 2186        | 2147        | 2107        | 2068        | 2030        | 1999        |
| 49 | 2432        | 2390        | 2348        | 2307        | 2266        | 2226        | 2186        | 2146        | 2107        | 2068        | 2029        | 1999        |
| 50 | 2431        | 2389        | 2348        | 2306        | 2266        | 2225        | 2185        | 2145        | 2106        | 2067        | 2028        | 1999        |
| 51 | 2431        | 2389        | 2347        | 2306        | 2265        | 2225        | 2184        | 2145        | 2105        | 2066        | 2028        | 1998        |
| 52 | 2430        | 2388        | 2346        | 2305        | 2264        | 2224        | 2184        | 2144        | 2105        | 2066        | 2027        | 1998        |
| 53 | 2429        | 2387        | 2346        | 2304        | 2264        | 2223        | 2183        | 2143        | 2104        | 2065        | 2026        | 1998        |
| 54 | 2429        | 2387        | 2345        | 2304        | 2263        | 2223        | 2182        | 2143        | 2103        | 2064        | 2026        | 1998        |
| 55 | 2428        | 2386        | 2344        | 2303        | 2262        | 2222        | 2182        | 2142        | 2103        | 2064        | 2025        | 1998        |
| 56 | 2427        | 2385        | 2344        | 2302        | 2262        | 2221        | 2181        | 2141        | 2102        | 2063        | 2024        | 1998        |
| 57 | 2426        | 2384        | 2343        | 2302        | 2261        | 2220        | 2180        | 2141        | 2101        | 2062        | 2024        | 1998        |
| 58 | 2426        | 2384        | 2342        | 2301        | 2260        | 2220        | 2180        | 2140        | 2101        | 2062        | 2023        | 1998        |
| 59 | 2425        | 2383        | 2341        | 2300        | 2260        | 2219        | 2179        | 2139        | 2100        | 2061        | 2023        | 1998        |
| 60 | 2424        | 2382        | 2341        | 2300        | 2259        | 2218        | 2178        | 2139        | 2099        | 2061        | 2022        | 1998        |

TABLE IX. PROPORTIONAL LOGARITHMS.

| S  | h<br>1° 54' | h<br>1° 55' | h<br>1° 56' | h<br>1° 57' | h<br>1° 58' | h<br>1° 59' | h<br>2° 0' | h<br>2° 1' | h<br>2° 2' | h<br>2° 3' | h<br>2° 4' |
|----|-------------|-------------|-------------|-------------|-------------|-------------|------------|------------|------------|------------|------------|
| 0  | 1984        | 1946        | 1908        | 1871        | 1834        | 1797        | 1761       | 1725       | 1689       | 1654       | 1619       |
| 1  | 1983        | 1945        | 1907        | 1870        | 1833        | 1797        | 1760       | 1724       | 1688       | 1653       | 1618       |
| 2  | 1982        | 1944        | 1907        | 1870        | 1833        | 1796        | 1760       | 1724       | 1688       | 1652       | 1617       |
| 3  | 1982        | 1944        | 1906        | 1869        | 1832        | 1795        | 1759       | 1723       | 1687       | 1652       | 1617       |
| 4  | 1981        | 1943        | 1906        | 1868        | 1831        | 1795        | 1758       | 1722       | 1687       | 1651       | 1616       |
| 5  | 1980        | 1943        | 1905        | 1868        | 1831        | 1794        | 1758       | 1722       | 1686       | 1651       | 1616       |
| 6  | 1980        | 1942        | 1904        | 1867        | 1830        | 1794        | 1757       | 1721       | 1685       | 1650       | 1615       |
| 7  | 1979        | 1941        | 1904        | 1867        | 1830        | 1793        | 1756       | 1721       | 1685       | 1650       | 1614       |
| 8  | 1979        | 1941        | 1903        | 1866        | 1829        | 1792        | 1756       | 1720       | 1684       | 1649       | 1614       |
| 9  | 1978        | 1940        | 1903        | 1865        | 1828        | 1792        | 1755       | 1719       | 1684       | 1648       | 1613       |
| 10 | 1977        | 1939        | 1902        | 1865        | 1828        | 1791        | 1755       | 1719       | 1683       | 1648       | 1613       |
| 11 | 1977        | 1939        | 1901        | 1864        | 1827        | 1791        | 1754       | 1718       | 1683       | 1647       | 1612       |
| 12 | 1976        | 1938        | 1901        | 1863        | 1827        | 1790        | 1754       | 1718       | 1682       | 1647       | 1612       |
| 13 | 1975        | 1938        | 1900        | 1863        | 1826        | 1789        | 1753       | 1717       | 1681       | 1646       | 1611       |
| 14 | 1975        | 1937        | 1899        | 1862        | 1825        | 1789        | 1752       | 1716       | 1681       | 1645       | 1610       |
| 15 | 1974        | 1936        | 1899        | 1862        | 1825        | 1788        | 1752       | 1716       | 1680       | 1645       | 1610       |
| 16 | 1973        | 1936        | 1898        | 1861        | 1824        | 1787        | 1751       | 1715       | 1680       | 1644       | 1609       |
| 17 | 1973        | 1935        | 1898        | 1860        | 1823        | 1787        | 1751       | 1715       | 1679       | 1644       | 1609       |
| 18 | 1972        | 1934        | 1897        | 1860        | 1823        | 1786        | 1750       | 1714       | 1678       | 1643       | 1608       |
| 19 | 1972        | 1934        | 1896        | 1859        | 1822        | 1786        | 1749       | 1713       | 1678       | 1642       | 1607       |
| 20 | 1971        | 1933        | 1896        | 1858        | 1822        | 1785        | 1749       | 1713       | 1677       | 1642       | 1607       |
| 21 | 1970        | 1933        | 1895        | 1858        | 1821        | 1785        | 1748       | 1712       | 1677       | 1641       | 1606       |
| 22 | 1970        | 1932        | 1894        | 1857        | 1820        | 1784        | 1748       | 1712       | 1676       | 1641       | 1606       |
| 23 | 1969        | 1931        | 1894        | 1857        | 1820        | 1783        | 1747       | 1711       | 1675       | 1640       | 1605       |
| 24 | 1968        | 1931        | 1893        | 1856        | 1819        | 1783        | 1746       | 1711       | 1675       | 1640       | 1605       |
| 25 | 1968        | 1930        | 1893        | 1855        | 1819        | 1782        | 1746       | 1710       | 1674       | 1639       | 1604       |
| 26 | 1967        | 1929        | 1892        | 1855        | 1818        | 1781        | 1745       | 1709       | 1674       | 1638       | 1603       |
| 27 | 1967        | 1929        | 1891        | 1854        | 1817        | 1781        | 1745       | 1709       | 1673       | 1638       | 1603       |
| 28 | 1966        | 1928        | 1891        | 1854        | 1817        | 1780        | 1744       | 1708       | 1673       | 1637       | 1602       |
| 29 | 1965        | 1927        | 1890        | 1853        | 1816        | 1780        | 1743       | 1708       | 1672       | 1637       | 1602       |
| 30 | 1965        | 1927        | 1889        | 1852        | 1816        | 1779        | 1743       | 1707       | 1671       | 1636       | 1601       |
| 31 | 1964        | 1926        | 1889        | 1852        | 1815        | 1778        | 1742       | 1706       | 1671       | 1635       | 1600       |
| 32 | 1963        | 1926        | 1888        | 1851        | 1814        | 1778        | 1742       | 1706       | 1670       | 1635       | 1600       |
| 33 | 1963        | 1925        | 1888        | 1850        | 1814        | 1777        | 1741       | 1705       | 1670       | 1634       | 1599       |
| 34 | 1962        | 1924        | 1887        | 1850        | 1813        | 1777        | 1740       | 1705       | 1669       | 1634       | 1599       |
| 35 | 1961        | 1924        | 1886        | 1849        | 1812        | 1776        | 1740       | 1704       | 1668       | 1633       | 1598       |
| 36 | 1961        | 1923        | 1886        | 1849        | 1812        | 1775        | 1739       | 1703       | 1668       | 1633       | 1598       |
| 37 | 1960        | 1922        | 1885        | 1848        | 1811        | 1775        | 1739       | 1703       | 1667       | 1632       | 1597       |
| 38 | 1960        | 1922        | 1884        | 1847        | 1811        | 1774        | 1738       | 1702       | 1667       | 1631       | 1596       |
| 39 | 1959        | 1921        | 1884        | 1847        | 1810        | 1774        | 1737       | 1702       | 1666       | 1631       | 1596       |
| 40 | 1958        | 1921        | 1883        | 1846        | 1809        | 1773        | 1737       | 1701       | 1665       | 1630       | 1595       |
| 41 | 1958        | 1920        | 1883        | 1846        | 1809        | 1772        | 1736       | 1700       | 1665       | 1630       | 1595       |
| 42 | 1957        | 1919        | 1882        | 1845        | 1808        | 1772        | 1736       | 1700       | 1664       | 1629       | 1594       |
| 43 | 1956        | 1919        | 1881        | 1844        | 1808        | 1771        | 1735       | 1699       | 1664       | 1628       | 1593       |
| 44 | 1956        | 1918        | 1881        | 1844        | 1807        | 1771        | 1734       | 1699       | 1663       | 1628       | 1593       |
| 45 | 1955        | 1918        | 1880        | 1843        | 1806        | 1770        | 1734       | 1698       | 1663       | 1627       | 1592       |
| 46 | 1955        | 1917        | 1879        | 1842        | 1806        | 1769        | 1733       | 1697       | 1662       | 1627       | 1592       |
| 47 | 1954        | 1916        | 1879        | 1842        | 1805        | 1769        | 1733       | 1697       | 1661       | 1626       | 1591       |
| 48 | 1953        | 1916        | 1878        | 1841        | 1805        | 1768        | 1732       | 1696       | 1661       | 1626       | 1591       |
| 49 | 1953        | 1915        | 1878        | 1841        | 1804        | 1768        | 1731       | 1696       | 1660       | 1625       | 1590       |
| 50 | 1952        | 1914        | 1877        | 1840        | 1803        | 1767        | 1731       | 1695       | 1660       | 1624       | 1589       |
| 51 | 1951        | 1914        | 1876        | 1839        | 1803        | 1766        | 1730       | 1694       | 1659       | 1624       | 1589       |
| 52 | 1951        | 1913        | 1876        | 1839        | 1802        | 1766        | 1730       | 1694       | 1658       | 1623       | 1588       |
| 53 | 1950        | 1912        | 1875        | 1838        | 1801        | 1765        | 1729       | 1693       | 1658       | 1623       | 1588       |
| 54 | 1950        | 1912        | 1875        | 1838        | 1801        | 1765        | 1728       | 1693       | 1657       | 1622       | 1587       |
| 55 | 1949        | 1911        | 1874        | 1837        | 1800        | 1764        | 1728       | 1692       | 1657       | 1621       | 1587       |
| 56 | 1948        | 1911        | 1873        | 1836        | 1799        | 1763        | 1727       | 1691       | 1656       | 1621       | 1586       |
| 57 | 1948        | 1910        | 1873        | 1836        | 1799        | 1763        | 1727       | 1691       | 1655       | 1620       | 1586       |
| 58 | 1947        | 1909        | 1872        | 1835        | 1798        | 1762        | 1726       | 1690       | 1655       | 1620       | 1585       |
| 59 | 1946        | 1909        | 1871        | 1834        | 1798        | 1761        | 1725       | 1690       | 1654       | 1619       | 1584       |
| 60 | 1946        | 1908        | 1871        | 1834        | 1797        | 1761        | 1725       | 1689       | 1654       | 1619       | 1584       |



TABLE IX. PROPORTIONAL LOGARITHMS.

| S  | h<br>2° 5' | h<br>2° 6' | h<br>2° 7' | h<br>2° 8' | h<br>2° 9' | h<br>2° 10' | h<br>2° 11' | h<br>2° 12' | h<br>2° 13' | h<br>2° 14' | h<br>2° 15' |
|----|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 0  | 1584       | 1549       | 1515       | 1481       | 1447       | 1413        | 1380        | 1347        | 1314        | 1282        | 1249        |
| 1  | 1583       | 1548       | 1514       | 1480       | 1446       | 1413        | 1379        | 1346        | 1314        | 1281        | 1249        |
| 2  | 1582       | 1548       | 1514       | 1479       | 1446       | 1412        | 1379        | 1346        | 1313        | 1281        | 1248        |
| 3  | 1582       | 1547       | 1513       | 1479       | 1445       | 1412        | 1378        | 1345        | 1313        | 1280        | 1248        |
| 4  | 1581       | 1547       | 1512       | 1478       | 1445       | 1411        | 1378        | 1345        | 1312        | 1279        | 1247        |
| 5  | 1581       | 1546       | 1512       | 1478       | 1444       | 1410        | 1377        | 1344        | 1311        | 1279        | 1247        |
| 6  | 1580       | 1546       | 1511       | 1477       | 1443       | 1410        | 1377        | 1344        | 1311        | 1278        | 1246        |
| 7  | 1580       | 1545       | 1511       | 1477       | 1443       | 1409        | 1376        | 1343        | 1310        | 1278        | 1246        |
| 8  | 1579       | 1544       | 1510       | 1476       | 1442       | 1409        | 1376        | 1343        | 1310        | 1277        | 1245        |
| 9  | 1578       | 1544       | 1510       | 1476       | 1442       | 1408        | 1375        | 1342        | 1309        | 1277        | 1245        |
| 10 | 1578       | 1543       | 1509       | 1475       | 1441       | 1408        | 1374        | 1341        | 1309        | 1276        | 1244        |
| 11 | 1577       | 1543       | 1508       | 1474       | 1441       | 1407        | 1374        | 1341        | 1308        | 1276        | 1243        |
| 12 | 1577       | 1542       | 1508       | 1474       | 1440       | 1407        | 1373        | 1340        | 1308        | 1275        | 1243        |
| 13 | 1576       | 1542       | 1507       | 1473       | 1440       | 1406        | 1373        | 1340        | 1307        | 1275        | 1242        |
| 14 | 1575       | 1541       | 1507       | 1473       | 1439       | 1405        | 1372        | 1339        | 1307        | 1274        | 1242        |
| 15 | 1575       | 1540       | 1506       | 1472       | 1438       | 1405        | 1372        | 1339        | 1306        | 1274        | 1241        |
| 16 | 1574       | 1540       | 1506       | 1472       | 1438       | 1404        | 1371        | 1338        | 1305        | 1273        | 1241        |
| 17 | 1574       | 1539       | 1505       | 1471       | 1437       | 1404        | 1371        | 1338        | 1305        | 1273        | 1240        |
| 18 | 1573       | 1539       | 1504       | 1470       | 1437       | 1403        | 1370        | 1337        | 1304        | 1272        | 1240        |
| 19 | 1573       | 1538       | 1504       | 1470       | 1436       | 1403        | 1369        | 1337        | 1304        | 1271        | 1239        |
| 20 | 1572       | 1538       | 1503       | 1469       | 1436       | 1402        | 1369        | 1336        | 1303        | 1271        | 1239        |
| 21 | 1571       | 1537       | 1503       | 1469       | 1435       | 1402        | 1368        | 1335        | 1303        | 1270        | 1238        |
| 22 | 1571       | 1536       | 1502       | 1468       | 1434       | 1401        | 1368        | 1335        | 1302        | 1270        | 1238        |
| 23 | 1570       | 1536       | 1502       | 1468       | 1434       | 1400        | 1367        | 1334        | 1302        | 1269        | 1237        |
| 24 | 1570       | 1535       | 1501       | 1467       | 1433       | 1400        | 1367        | 1334        | 1301        | 1269        | 1237        |
| 25 | 1569       | 1535       | 1500       | 1466       | 1433       | 1399        | 1366        | 1333        | 1301        | 1268        | 1236        |
| 26 | 1569       | 1534       | 1500       | 1466       | 1432       | 1399        | 1366        | 1333        | 1300        | 1268        | 1235        |
| 27 | 1568       | 1534       | 1499       | 1465       | 1432       | 1398        | 1365        | 1332        | 1300        | 1267        | 1235        |
| 28 | 1567       | 1533       | 1499       | 1465       | 1431       | 1398        | 1365        | 1332        | 1299        | 1267        | 1234        |
| 29 | 1567       | 1532       | 1498       | 1464       | 1431       | 1397        | 1364        | 1331        | 1298        | 1266        | 1234        |
| 30 | 1566       | 1532       | 1498       | 1464       | 1430       | 1397        | 1363        | 1331        | 1298        | 1266        | 1233        |
| 31 | 1566       | 1531       | 1497       | 1463       | 1429       | 1396        | 1363        | 1330        | 1297        | 1265        | 1233        |
| 32 | 1565       | 1531       | 1496       | 1463       | 1429       | 1395        | 1362        | 1329        | 1297        | 1264        | 1232        |
| 33 | 1565       | 1530       | 1496       | 1462       | 1428       | 1395        | 1362        | 1329        | 1296        | 1264        | 1232        |
| 34 | 1564       | 1529       | 1495       | 1461       | 1428       | 1394        | 1361        | 1328        | 1296        | 1263        | 1231        |
| 35 | 1563       | 1529       | 1495       | 1461       | 1427       | 1394        | 1361        | 1328        | 1295        | 1263        | 1231        |
| 36 | 1563       | 1528       | 1494       | 1460       | 1427       | 1393        | 1360        | 1327        | 1295        | 1262        | 1230        |
| 37 | 1562       | 1528       | 1494       | 1460       | 1426       | 1393        | 1360        | 1327        | 1294        | 1262        | 1230        |
| 38 | 1562       | 1527       | 1493       | 1459       | 1426       | 1392        | 1359        | 1326        | 1294        | 1261        | 1229        |
| 39 | 1561       | 1527       | 1493       | 1458       | 1425       | 1392        | 1359        | 1326        | 1293        | 1261        | 1229        |
| 40 | 1560       | 1526       | 1492       | 1458       | 1424       | 1391        | 1358        | 1325        | 1292        | 1260        | 1228        |
| 41 | 1560       | 1525       | 1491       | 1457       | 1424       | 1390        | 1357        | 1325        | 1292        | 1260        | 1227        |
| 42 | 1559       | 1525       | 1491       | 1457       | 1423       | 1390        | 1357        | 1324        | 1291        | 1259        | 1227        |
| 43 | 1559       | 1524       | 1490       | 1456       | 1423       | 1389        | 1356        | 1323        | 1291        | 1258        | 1226        |
| 44 | 1558       | 1524       | 1490       | 1456       | 1422       | 1389        | 1356        | 1323        | 1290        | 1258        | 1226        |
| 45 | 1558       | 1523       | 1489       | 1455       | 1422       | 1388        | 1355        | 1322        | 1290        | 1257        | 1225        |
| 46 | 1557       | 1523       | 1489       | 1455       | 1421       | 1388        | 1355        | 1322        | 1289        | 1257        | 1225        |
| 47 | 1556       | 1522       | 1488       | 1454       | 1420       | 1387        | 1354        | 1321        | 1289        | 1256        | 1224        |
| 48 | 1556       | 1522       | 1487       | 1454       | 1420       | 1387        | 1354        | 1321        | 1288        | 1256        | 1224        |
| 49 | 1555       | 1521       | 1487       | 1453       | 1419       | 1386        | 1353        | 1320        | 1288        | 1255        | 1223        |
| 50 | 1555       | 1520       | 1486       | 1452       | 1419       | 1386        | 1352        | 1320        | 1287        | 1255        | 1223        |
| 51 | 1554       | 1520       | 1486       | 1452       | 1418       | 1385        | 1352        | 1319        | 1287        | 1254        | 1222        |
| 52 | 1554       | 1519       | 1485       | 1451       | 1418       | 1384        | 1351        | 1319        | 1286        | 1254        | 1222        |
| 53 | 1553       | 1519       | 1485       | 1451       | 1417       | 1384        | 1351        | 1318        | 1285        | 1253        | 1221        |
| 54 | 1552       | 1518       | 1484       | 1450       | 1417       | 1383        | 1350        | 1317        | 1285        | 1253        | 1221        |
| 55 | 1552       | 1518       | 1483       | 1450       | 1416       | 1383        | 1350        | 1317        | 1284        | 1252        | 1220        |
| 56 | 1551       | 1517       | 1483       | 1449       | 1415       | 1382        | 1349        | 1316        | 1284        | 1251        | 1219        |
| 57 | 1551       | 1516       | 1482       | 1449       | 1415       | 1382        | 1349        | 1316        | 1283        | 1251        | 1219        |
| 58 | 1550       | 1516       | 1482       | 1448       | 1414       | 1381        | 1348        | 1315        | 1283        | 1250        | 1218        |
| 59 | 1550       | 1515       | 1481       | 1447       | 1414       | 1381        | 1347        | 1315        | 1282        | 1250        | 1218        |
| 60 | 1549       | 1515       | 1481       | 1447       | 1413       | 1380        | 1347        | 1314        | 1282        | 1249        | 1217        |

TABLE IX. PROPORTIONAL LOGARITHMS.

| S  | h<br>2° 16' | h<br>2° 17' | h<br>2° 18' | h<br>2° 19' | h<br>2° 20' | h<br>2° 21' | h<br>2° 22' | h<br>2° 23' | h<br>2° 24' | h<br>2° 25' | h<br>2° 26' |
|----|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 0  | 1217        | 1186        | 1154        | 1123        | 1091        | 1061        | 1030        | 0999        | 0969        | 0939        | 0909        |
| 1  | 1217        | 1185        | 1153        | 1122        | 1091        | 1060        | 1029        | 999         | 969         | 939         | 909         |
| 2  | 1216        | 1184        | 1153        | 1121        | 1090        | 1059        | 1029        | 998         | 968         | 938         | 908         |
| 3  | 1216        | 1184        | 1152        | 1121        | 1090        | 1059        | 1028        | 998         | 968         | 938         | 908         |
| 4  | 1215        | 1183        | 1152        | 1120        | 1089        | 1058        | 1028        | 997         | 967         | 937         | 907         |
| 5  | 1215        | 1183        | 1151        | 1120        | 1089        | 1058        | 1027        | 997         | 967         | 937         | 907         |
| 6  | 1214        | 1182        | 1151        | 1119        | 1088        | 1057        | 1027        | 996         | 966         | 936         | 906         |
| 7  | 1214        | 1182        | 1150        | 1119        | 1088        | 1057        | 1026        | 996         | 966         | 936         | 906         |
| 8  | 1213        | 1181        | 1150        | 1118        | 1087        | 1056        | 1026        | 995         | 965         | 935         | 905         |
| 9  | 1213        | 1181        | 1149        | 1118        | 1087        | 1056        | 1025        | 995         | 965         | 935         | 905         |
| 10 | 1212        | 1180        | 1149        | 1117        | 1086        | 1055        | 1025        | 0994        | 0964        | 0934        | 0904        |
| 11 | 1211        | 1180        | 1148        | 1117        | 1086        | 1055        | 1024        | 994         | 964         | 934         | 904         |
| 12 | 1211        | 1179        | 1148        | 1116        | 1085        | 1054        | 1024        | 993         | 963         | 933         | 903         |
| 13 | 1210        | 1179        | 1147        | 1116        | 1085        | 1054        | 1023        | 993         | 963         | 933         | 903         |
| 14 | 1210        | 1178        | 1147        | 1115        | 1084        | 1053        | 1023        | 992         | 962         | 932         | 902         |
| 15 | 1209        | 1178        | 1146        | 1115        | 1084        | 1053        | 1022        | 992         | 962         | 932         | 902         |
| 16 | 1209        | 1177        | 1146        | 1114        | 1083        | 1052        | 1022        | 991         | 961         | 931         | 901         |
| 17 | 1208        | 1177        | 1145        | 1114        | 1083        | 1052        | 1021        | 991         | 961         | 931         | 901         |
| 18 | 1208        | 1176        | 1145        | 1113        | 1082        | 1051        | 1021        | 990         | 960         | 930         | 900         |
| 19 | 1207        | 1175        | 1144        | 1113        | 1082        | 1051        | 1020        | 990         | 960         | 930         | 900         |
| 20 | 1207        | 1175        | 1143        | 1112        | 1081        | 1050        | 1020        | 0989        | 0959        | 0929        | 0899        |
| 21 | 1206        | 1174        | 1143        | 1112        | 1081        | 1050        | 1019        | 989         | 959         | 929         | 899         |
| 22 | 1206        | 1174        | 1142        | 1111        | 1080        | 1049        | 1019        | 988         | 958         | 928         | 898         |
| 23 | 1205        | 1173        | 1142        | 1111        | 1080        | 1049        | 1018        | 988         | 958         | 928         | 898         |
| 24 | 1205        | 1173        | 1141        | 1110        | 1079        | 1048        | 1018        | 987         | 957         | 927         | 897         |
| 25 | 1204        | 1172        | 1141        | 1110        | 1079        | 1048        | 1017        | 987         | 957         | 927         | 897         |
| 26 | 1203        | 1172        | 1140        | 1109        | 1078        | 1047        | 1017        | 986         | 956         | 926         | 896         |
| 27 | 1203        | 1171        | 1140        | 1109        | 1078        | 1047        | 1016        | 986         | 956         | 926         | 896         |
| 28 | 1202        | 1171        | 1139        | 1108        | 1077        | 1046        | 1016        | 985         | 955         | 925         | 895         |
| 29 | 1202        | 1170        | 1139        | 1107        | 1076        | 1046        | 1015        | 985         | 955         | 925         | 895         |
| 30 | 1201        | 1170        | 1138        | 1107        | 1076        | 1045        | 1015        | 0984        | 0954        | 0924        | 0894        |
| 31 | 1201        | 1169        | 1138        | 1106        | 1075        | 1045        | 1014        | 984         | 954         | 924         | 894         |
| 32 | 1200        | 1169        | 1137        | 1106        | 1075        | 1044        | 1014        | 983         | 953         | 923         | 893         |
| 33 | 1200        | 1168        | 1137        | 1105        | 1074        | 1044        | 1013        | 983         | 953         | 923         | 893         |
| 34 | 1199        | 1168        | 1136        | 1105        | 1074        | 1043        | 1013        | 982         | 952         | 922         | 892         |
| 35 | 1199        | 1167        | 1136        | 1104        | 1073        | 1043        | 1012        | 982         | 952         | 922         | 892         |
| 36 | 1198        | 1167        | 1135        | 1104        | 1073        | 1042        | 1012        | 981         | 951         | 921         | 891         |
| 37 | 1198        | 1166        | 1135        | 1103        | 1072        | 1042        | 1011        | 981         | 951         | 921         | 891         |
| 38 | 1197        | 1165        | 1134        | 1103        | 1072        | 1041        | 1010        | 980         | 950         | 920         | 890         |
| 39 | 1197        | 1165        | 1134        | 1102        | 1071        | 1041        | 1010        | 980         | 950         | 920         | 890         |
| 40 | 1196        | 1164        | 1133        | 1102        | 1071        | 1040        | 1009        | 0979        | 0949        | 0919        | 0889        |
| 41 | 1196        | 1164        | 1132        | 1101        | 1070        | 1039        | 1009        | 979         | 949         | 919         | 889         |
| 42 | 1195        | 1163        | 1132        | 1101        | 1070        | 1039        | 1008        | 978         | 948         | 918         | 888         |
| 43 | 1194        | 1163        | 1131        | 1100        | 1069        | 1038        | 1008        | 978         | 948         | 918         | 888         |
| 44 | 1194        | 1162        | 1131        | 1100        | 1069        | 1038        | 1007        | 977         | 947         | 917         | 887         |
| 45 | 1193        | 1162        | 1130        | 1099        | 1068        | 1037        | 1007        | 977         | 947         | 917         | 887         |
| 46 | 1193        | 1161        | 1130        | 1099        | 1068        | 1037        | 1006        | 976         | 946         | 916         | 886         |
| 47 | 1192        | 1161        | 1129        | 1098        | 1067        | 1036        | 1006        | 976         | 946         | 916         | 886         |
| 48 | 1192        | 1160        | 1129        | 1098        | 1067        | 1036        | 1005        | 975         | 945         | 915         | 885         |
| 49 | 1191        | 1160        | 1128        | 1097        | 1066        | 1035        | 1005        | 975         | 945         | 915         | 885         |
| 50 | 1191        | 1159        | 1128        | 1097        | 1066        | 1035        | 1004        | 0974        | 0944        | 0914        | 0884        |
| 51 | 1190        | 1159        | 1127        | 1096        | 1065        | 1034        | 1004        | 974         | 944         | 914         | 884         |
| 52 | 1190        | 1158        | 1127        | 1096        | 1065        | 1034        | 1003        | 973         | 943         | 913         | 883         |
| 53 | 1189        | 1158        | 1126        | 1095        | 1064        | 1033        | 1003        | 973         | 943         | 913         | 883         |
| 54 | 1189        | 1157        | 1126        | 1095        | 1064        | 1033        | 1002        | 972         | 942         | 912         | 883         |
| 55 | 1188        | 1157        | 1125        | 1094        | 1063        | 1032        | 1002        | 972         | 942         | 912         | 882         |
| 56 | 1188        | 1156        | 1125        | 1093        | 1063        | 1032        | 1001        | 971         | 941         | 911         | 882         |
| 57 | 1187        | 1156        | 1124        | 1093        | 1062        | 1031        | 1001        | 971         | 941         | 911         | 881         |
| 58 | 1187        | 1155        | 1124        | 1092        | 1062        | 1031        | 1000        | 970         | 940         | 910         | 881         |
| 59 | 1186        | 1154        | 1123        | 1092        | 1061        | 1030        | 1000        | 970         | 940         | 910         | 880         |
| 60 | 1186        | 1154        | 1123        | 1091        | 1061        | 1030        | 0999        | 0969        | 0939        | 0909        | 0880        |

TABLE IX. PROPORTIONAL LOGARITHMS.

| S. | h<br>2° 27' | h<br>2° 28' | h<br>2° 29' | h<br>2° 30' | h<br>2° 31' | h<br>2° 32' | h<br>2° 33' | h<br>2° 34' | h<br>2° 35' | h<br>2° 36' | h<br>2° 37' |
|----|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 0  | 0880        | 0850        | 0821        | 0792        | 0763        | 0734        | 0706        | 0678        | 0649        | 0621        | 0594        |
| 1  | 879         | 850         | 820         | 791         | 762         | 734         | 705         | 677         | 649         | 621         | 593         |
| 2  | 879         | 849         | 820         | 791         | 762         | 733         | 705         | 677         | 648         | 621         | 593         |
| 3  | 878         | 849         | 819         | 790         | 762         | 733         | 704         | 676         | 648         | 620         | 592         |
| 4  | 878         | 848         | 819         | 790         | 761         | 732         | 704         | 676         | 648         | 620         | 592         |
| 5  | 877         | 848         | 818         | 789         | 761         | 732         | 703         | 675         | 647         | 619         | 591         |
| 6  | 877         | 847         | 818         | 789         | 760         | 731         | 703         | 675         | 647         | 619         | 591         |
| 7  | 876         | 847         | 817         | 788         | 760         | 731         | 702         | 674         | 646         | 618         | 590         |
| 8  | 876         | 846         | 817         | 788         | 759         | 730         | 702         | 674         | 646         | 618         | 590         |
| 9  | 875         | 846         | 816         | 787         | 759         | 730         | 702         | 673         | 645         | 617         | 590         |
| 10 | 0875        | 0845        | 0816        | 0787        | 0758        | 0729        | 0701        | 0673        | 0645        | 0617        | 0589        |
| 11 | 874         | 845         | 815         | 787         | 758         | 729         | 701         | 672         | 644         | 616         | 589         |
| 12 | 874         | 844         | 815         | 786         | 757         | 729         | 700         | 672         | 644         | 616         | 588         |
| 13 | 873         | 844         | 814         | 786         | 757         | 728         | 700         | 671         | 643         | 615         | 588         |
| 14 | 873         | 843         | 814         | 785         | 756         | 728         | 699         | 671         | 643         | 615         | 587         |
| 15 | 872         | 843         | 814         | 785         | 756         | 727         | 699         | 670         | 642         | 615         | 587         |
| 16 | 872         | 842         | 813         | 784         | 755         | 727         | 698         | 670         | 642         | 614         | 586         |
| 17 | 871         | 842         | 813         | 784         | 755         | 726         | 698         | 669         | 641         | 614         | 586         |
| 18 | 871         | 841         | 812         | 783         | 754         | 726         | 697         | 669         | 641         | 613         | 585         |
| 19 | 870         | 841         | 812         | 783         | 754         | 725         | 697         | 669         | 641         | 613         | 585         |
| 20 | 0870        | 0840        | 0811        | 0782        | 0753        | 0725        | 0696        | 0668        | 0640        | 0612        | 0584        |
| 21 | 869         | 840         | 811         | 782         | 753         | 724         | 696         | 668         | 640         | 612         | 584         |
| 22 | 869         | 839         | 810         | 781         | 752         | 724         | 695         | 667         | 639         | 611         | 584         |
| 23 | 868         | 839         | 810         | 781         | 752         | 723         | 695         | 667         | 639         | 611         | 583         |
| 24 | 868         | 838         | 809         | 780         | 751         | 723         | 694         | 666         | 638         | 610         | 583         |
| 25 | 867         | 838         | 809         | 780         | 751         | 722         | 694         | 666         | 638         | 610         | 582         |
| 26 | 867         | 837         | 808         | 779         | 750         | 722         | 693         | 665         | 637         | 609         | 582         |
| 27 | 866         | 837         | 808         | 779         | 750         | 721         | 693         | 665         | 637         | 609         | 581         |
| 28 | 866         | 836         | 807         | 778         | 750         | 721         | 693         | 664         | 636         | 608         | 581         |
| 29 | 865         | 836         | 807         | 778         | 749         | 720         | 692         | 664         | 636         | 608         | 580         |
| 30 | 0865        | 0835        | 0806        | 0777        | 0749        | 0720        | 0692        | 0663        | 0635        | 0608        | 0580        |
| 31 | 864         | 835         | 806         | 777         | 748         | 720         | 691         | 663         | 635         | 607         | 579         |
| 32 | 864         | 834         | 805         | 776         | 748         | 719         | 691         | 662         | 634         | 607         | 579         |
| 33 | 863         | 834         | 805         | 776         | 747         | 719         | 690         | 662         | 634         | 606         | 579         |
| 34 | 863         | 833         | 804         | 775         | 747         | 718         | 690         | 662         | 634         | 606         | 578         |
| 35 | 862         | 833         | 804         | 775         | 746         | 718         | 689         | 661         | 633         | 605         | 578         |
| 36 | 862         | 833         | 803         | 774         | 746         | 717         | 689         | 661         | 633         | 605         | 577         |
| 37 | 861         | 832         | 803         | 774         | 745         | 717         | 688         | 660         | 632         | 604         | 577         |
| 38 | 861         | 832         | 802         | 773         | 745         | 716         | 688         | 660         | 632         | 604         | 576         |
| 39 | 860         | 831         | 802         | 773         | 744         | 716         | 687         | 659         | 631         | 603         | 576         |
| 40 | 0860        | 0831        | 0801        | 0773        | 0744        | 0715        | 0687        | 0659        | 0631        | 0603        | 0575        |
| 41 | 859         | 830         | 801         | 772         | 743         | 715         | 686         | 658         | 630         | 602         | 575         |
| 42 | 859         | 830         | 801         | 772         | 743         | 714         | 686         | 658         | 630         | 602         | 574         |
| 43 | 858         | 829         | 800         | 771         | 742         | 714         | 685         | 657         | 629         | 602         | 574         |
| 44 | 858         | 829         | 800         | 771         | 742         | 713         | 685         | 657         | 629         | 601         | 573         |
| 45 | 857         | 828         | 799         | 770         | 741         | 713         | 685         | 656         | 628         | 601         | 573         |
| 46 | 857         | 828         | 799         | 770         | 741         | 712         | 684         | 656         | 628         | 600         | 573         |
| 47 | 856         | 827         | 798         | 769         | 740         | 712         | 684         | 655         | 627         | 600         | 572         |
| 48 | 856         | 827         | 798         | 769         | 740         | 711         | 683         | 655         | 627         | 599         | 572         |
| 49 | 855         | 826         | 797         | 768         | 739         | 711         | 683         | 655         | 627         | 599         | 571         |
| 50 | 0855        | 0826        | 0797        | 0768        | 0739        | 0711        | 0682        | 0654        | 0626        | 0598        | 0571        |
| 51 | 855         | 825         | 796         | 767         | 739         | 710         | 682         | 654         | 626         | 598         | 570         |
| 52 | 854         | 825         | 796         | 767         | 738         | 710         | 681         | 653         | 625         | 597         | 570         |
| 53 | 854         | 824         | 795         | 766         | 738         | 709         | 681         | 653         | 625         | 597         | 569         |
| 54 | 853         | 824         | 795         | 766         | 737         | 709         | 680         | 652         | 624         | 596         | 569         |
| 55 | 853         | 823         | 794         | 765         | 737         | 708         | 680         | 652         | 624         | 596         | 568         |
| 56 | 852         | 823         | 794         | 765         | 736         | 708         | 679         | 651         | 623         | 596         | 568         |
| 57 | 852         | 822         | 793         | 764         | 736         | 707         | 679         | 651         | 623         | 595         | 568         |
| 58 | 851         | 822         | 793         | 764         | 735         | 707         | 678         | 650         | 622         | 595         | 567         |
| 59 | 851         | 821         | 792         | 763         | 735         | 706         | 678         | 650         | 622         | 594         | 567         |
| 60 | 0850        | 0821        | 0792        | 0763        | 0734        | 0706        | 0678        | 0649        | 0621        | 0594        | 0566        |



TABLE IX. PROPORTIONAL LOGARITHMS.

| S. | h<br>2° 38' | h<br>2° 39' | h<br>2° 40' | h<br>2° 41' | h<br>2° 42' | h<br>2° 43' | h<br>2° 44' | h<br>2° 45' | h<br>2° 46' | h<br>2° 47' | h<br>2° 48' |
|----|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 0  | 0566        | 0539        | 0512        | 0484        | 0458        | 0431        | 1404        | 0378        | 0352        | 0326        | 0300        |
| 1  | 566         | 538         | 511         | 484         | 457         | 430         | 404         | 377         | 351         | 325         | 299         |
| 2  | 565         | 538         | 511         | 484         | 457         | 430         | 403         | 377         | 351         | 325         | 299         |
| 3  | 565         | 537         | 510         | 483         | 456         | 430         | 403         | 377         | 350         | 324         | 298         |
| 4  | 564         | 537         | 510         | 483         | 456         | 429         | 402         | 376         | 350         | 324         | 298         |
| 5  | 564         | 536         | 509         | 482         | 455         | 429         | 402         | 376         | 349         | 323         | 297         |
| 6  | 563         | 536         | 509         | 482         | 455         | 428         | 402         | 375         | 349         | 323         | 297         |
| 7  | 563         | 536         | 508         | 481         | 454         | 428         | 401         | 375         | 349         | 322         | 297         |
| 8  | 562         | 535         | 508         | 481         | 454         | 427         | 401         | 374         | 348         | 322         | 296         |
| 9  | 562         | 535         | 507         | 480         | 454         | 427         | 400         | 374         | 348         | 322         | 296         |
| 10 | 0562        | 0534        | 0507        | 0480        | 0453        | 0426        | 0400        | 0373        | 0347        | 0321        | 0295        |
| 11 | 561         | 534         | 507         | 479         | 453         | 426         | 399         | 373         | 347         | 321         | 295         |
| 12 | 561         | 533         | 506         | 479         | 452         | 426         | 399         | 373         | 346         | 320         | 294         |
| 13 | 560         | 533         | 506         | 479         | 452         | 425         | 399         | 372         | 346         | 320         | 294         |
| 14 | 560         | 532         | 505         | 478         | 451         | 425         | 398         | 372         | 346         | 319         | 294         |
| 15 | 559         | 532         | 505         | 478         | 451         | 424         | 398         | 371         | 345         | 319         | 293         |
| 16 | 559         | 531         | 504         | 477         | 450         | 424         | 397         | 371         | 345         | 319         | 293         |
| 17 | 558         | 531         | 504         | 477         | 450         | 423         | 397         | 370         | 344         | 318         | 292         |
| 18 | 558         | 531         | 503         | 476         | 450         | 423         | 396         | 370         | 344         | 318         | 292         |
| 19 | 557         | 530         | 503         | 476         | 449         | 422         | 396         | 370         | 343         | 317         | 291         |
| 20 | 0557        | 0530        | 0502        | 0475        | 0449        | 0422        | 0395        | 0369        | 0343        | 0317        | 0291        |
| 21 | 557         | 529         | 502         | 475         | 448         | 422         | 395         | 369         | 342         | 316         | 291         |
| 22 | 556         | 529         | 502         | 475         | 448         | 421         | 395         | 368         | 342         | 316         | 290         |
| 23 | 556         | 528         | 501         | 474         | 447         | 421         | 394         | 368         | 342         | 316         | 290         |
| 24 | 555         | 528         | 501         | 474         | 447         | 420         | 394         | 367         | 341         | 315         | 289         |
| 25 | 555         | 527         | 500         | 473         | 446         | 420         | 393         | 367         | 341         | 315         | 289         |
| 26 | 554         | 527         | 500         | 473         | 446         | 419         | 393         | 366         | 340         | 314         | 288         |
| 27 | 554         | 526         | 499         | 472         | 446         | 419         | 392         | 366         | 340         | 314         | 288         |
| 28 | 553         | 526         | 499         | 472         | 445         | 418         | 392         | 366         | 339         | 313         | 288         |
| 29 | 553         | 526         | 498         | 471         | 445         | 418         | 391         | 365         | 339         | 313         | 287         |
| 30 | 0552        | 0525        | 0498        | 0471        | 0444        | 0418        | 0391        | 0365        | 0339        | 0313        | 0287        |
| 31 | 552         | 525         | 497         | 471         | 444         | 417         | 391         | 364         | 338         | 312         | 286         |
| 32 | 551         | 524         | 497         | 470         | 443         | 417         | 390         | 364         | 338         | 312         | 286         |
| 33 | 551         | 524         | 497         | 470         | 443         | 416         | 390         | 363         | 337         | 311         | 285         |
| 34 | 551         | 523         | 496         | 469         | 442         | 416         | 389         | 363         | 337         | 311         | 285         |
| 35 | 550         | 523         | 496         | 469         | 442         | 415         | 389         | 363         | 336         | 310         | 285         |
| 36 | 550         | 522         | 495         | 468         | 442         | 415         | 388         | 362         | 336         | 310         | 284         |
| 37 | 549         | 522         | 495         | 468         | 441         | 414         | 388         | 362         | 336         | 310         | 284         |
| 38 | 549         | 521         | 494         | 467         | 441         | 414         | 388         | 361         | 335         | 309         | 283         |
| 39 | 548         | 521         | 494         | 467         | 440         | 414         | 387         | 361         | 335         | 309         | 283         |
| 40 | 0548        | 0521        | 0493        | 0466        | 0440        | 0413        | 0387        | 0360        | 0334        | 0308        | 0282        |
| 41 | 547         | 520         | 493         | 466         | 439         | 413         | 386         | 360         | 334         | 308         | 282         |
| 42 | 547         | 520         | 493         | 466         | 439         | 412         | 386         | 359         | 333         | 307         | 282         |
| 43 | 546         | 519         | 492         | 465         | 438         | 412         | 385         | 359         | 333         | 307         | 281         |
| 44 | 546         | 519         | 492         | 465         | 438         | 411         | 385         | 359         | 332         | 306         | 281         |
| 45 | 546         | 518         | 491         | 464         | 438         | 411         | 384         | 358         | 332         | 306         | 280         |
| 46 | 545         | 518         | 491         | 464         | 437         | 410         | 384         | 358         | 332         | 306         | 280         |
| 47 | 545         | 517         | 490         | 463         | 437         | 410         | 384         | 357         | 331         | 305         | 279         |
| 48 | 544         | 517         | 490         | 463         | 436         | 410         | 383         | 357         | 331         | 305         | 279         |
| 49 | 544         | 516         | 489         | 462         | 436         | 409         | 383         | 356         | 330         | 304         | 279         |
| 50 | 0543        | 0516        | 0489        | 0462        | 0435        | 0409        | 0382        | 0356        | 0330        | 0304        | 0278        |
| 51 | 543         | 516         | 489         | 462         | 435         | 408         | 382         | 356         | 329         | 304         | 278         |
| 52 | 542         | 515         | 488         | 461         | 434         | 408         | 381         | 355         | 329         | 303         | 277         |
| 53 | 542         | 515         | 488         | 461         | 434         | 407         | 381         | 355         | 328         | 303         | 277         |
| 54 | 541         | 514         | 487         | 460         | 434         | 407         | 381         | 354         | 328         | 302         | 276         |
| 55 | 541         | 514         | 487         | 460         | 433         | 406         | 380         | 354         | 328         | 302         | 276         |
| 56 | 541         | 513         | 486         | 459         | 433         | 406         | 380         | 353         | 327         | 301         | 276         |
| 57 | 540         | 513         | 486         | 459         | 432         | 406         | 379         | 353         | 327         | 301         | 275         |
| 58 | 540         | 512         | 485         | 458         | 432         | 405         | 379         | 352         | 326         | 300         | 275         |
| 59 | 539         | 512         | 485         | 458         | 431         | 405         | 378         | 352         | 326         | 300         | 274         |
| 60 | 0539        | 0512        | 0484        | 0458        | 0431        | 0404        | 0376        | 0352        | 0326        | 0300        | 0274        |

TABLE IX. PROPORTIONAL LOGARITHMS.

| S  | h<br>2° 49' | h<br>2° 50' | h<br>2° 51' | h<br>2° 52' | h<br>2° 53' | h<br>2° 54' | h<br>2° 55' | h<br>2° 56' | h<br>2° 57' | h<br>2° 58' | h<br>2° 59' |
|----|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 0  | 0274        | 0248        | 0223        | 0197        | 0172        | 0147        | 0122        | 0098        | 0073        | 0049        | 0024        |
| 1  | 273         | 248         | 222         | 197         | 172         | 147         | 122         | 97          | 73          | 48          | 24          |
| 2  | 273         | 247         | 222         | 197         | 171         | 146         | 121         | 97          | 72          | 48          | 23          |
| 3  | 273         | 247         | 221         | 196         | 171         | 146         | 121         | 96          | 72          | 47          | 23          |
| 4  | 272         | 246         | 221         | 196         | 171         | 146         | 121         | 96          | 71          | 47          | 23          |
| 5  | 272         | 246         | 221         | 195         | 170         | 145         | 120         | 96          | 71          | 46          | 22          |
| 6  | 271         | 246         | 220         | 195         | 170         | 145         | 120         | 95          | 71          | 46          | 22          |
| 7  | 271         | 245         | 220         | 194         | 169         | 144         | 119         | 95          | 70          | 46          | 21          |
| 8  | 270         | 245         | 219         | 194         | 169         | 144         | 119         | 94          | 70          | 45          | 21          |
| 9  | 270         | 244         | 219         | 194         | 161         | 143         | 119         | 94          | 69          | 45          | 21          |
| 10 | 0270        | 0244        | 0218        | 0193        | 0168        | 0143        | 0118        | 0093        | 0069        | 0044        | 0020        |
| 11 | 269         | 244         | 218         | 193         | 168         | 143         | 118         | 93          | 68          | 44          | 20          |
| 12 | 269         | 243         | 218         | 192         | 167         | 142         | 117         | 93          | 68          | 44          | 19          |
| 13 | 268         | 243         | 217         | 192         | 167         | 142         | 117         | 92          | 68          | 43          | 19          |
| 14 | 268         | 242         | 217         | 192         | 166         | 141         | 117         | 92          | 67          | 43          | 18          |
| 15 | 267         | 242         | 216         | 191         | 166         | 141         | 116         | 91          | 67          | 42          | 18          |
| 16 | 267         | 241         | 216         | 191         | 166         | 141         | 116         | 91          | 66          | 42          | 18          |
| 17 | 267         | 241         | 216         | 190         | 165         | 140         | 115         | 91          | 66          | 42          | 17          |
| 18 | 266         | 241         | 215         | 190         | 165         | 140         | 115         | 90          | 66          | 41          | 17          |
| 19 | 266         | 240         | 215         | 189         | 164         | 139         | 114         | 90          | 65          | 41          | 16          |
| 20 | 0265        | 0240        | 0214        | 0189        | 0164        | 0139        | 0114        | 0089        | 0065        | 0040        | 0016        |
| 21 | 265         | 239         | 214         | 189         | 163         | 139         | 114         | 89          | 64          | 40          | 16          |
| 22 | 264         | 239         | 213         | 188         | 163         | 138         | 113         | 89          | 64          | 40          | 15          |
| 23 | 264         | 238         | 213         | 188         | 163         | 138         | 113         | 88          | 64          | 39          | 15          |
| 24 | 264         | 238         | 213         | 187         | 162         | 137         | 112         | 88          | 63          | 39          | 15          |
| 25 | 263         | 238         | 212         | 187         | 162         | 137         | 112         | 87          | 63          | 38          | 14          |
| 26 | 263         | 237         | 212         | 186         | 161         | 136         | 112         | 87          | 62          | 38          | 14          |
| 27 | 262         | 237         | 211         | 186         | 161         | 136         | 111         | 87          | 62          | 38          | 13          |
| 28 | 262         | 236         | 211         | 186         | 161         | 136         | 111         | 86          | 62          | 37          | 13          |
| 29 | 261         | 236         | 210         | 185         | 160         | 135         | 110         | 86          | 61          | 37          | 12          |
| 30 | 0261        | 0235        | 0210        | 0185        | 0160        | 0135        | 0110        | 0085        | 0061        | 0036        | 0012        |
| 31 | 261         | 235         | 210         | 184         | 159         | 134         | 110         | 85          | 60          | 36          | 12          |
| 32 | 260         | 235         | 209         | 184         | 159         | 134         | 109         | 84          | 60          | 35          | 11          |
| 33 | 260         | 234         | 209         | 184         | 158         | 134         | 109         | 84          | 60          | 35          | 11          |
| 34 | 259         | 234         | 208         | 183         | 158         | 133         | 108         | 84          | 59          | 35          | 10          |
| 35 | 259         | 233         | 208         | 183         | 158         | 133         | 108         | 83          | 59          | 34          | 10          |
| 36 | 258         | 233         | 208         | 182         | 157         | 132         | 107         | 83          | 58          | 34          | 10          |
| 37 | 258         | 232         | 207         | 182         | 157         | 132         | 107         | 82          | 58          | 33          | 09          |
| 38 | 258         | 232         | 207         | 181         | 156         | 131         | 107         | 82          | 57          | 33          | 09          |
| 39 | 257         | 232         | 206         | 181         | 156         | 131         | 106         | 82          | 57          | 33          | 08          |
| 40 | 0257        | 0231        | 0206        | 0181        | 0156        | 0131        | 0106        | 0081        | 0057        | 0032        | 0008        |
| 41 | 256         | 231         | 205         | 180         | 155         | 130         | 105         | 81          | 56          | 32          | 8           |
| 42 | 256         | 230         | 205         | 180         | 155         | 130         | 105         | 80          | 56          | 31          | 7           |
| 43 | 255         | 230         | 205         | 179         | 154         | 129         | 105         | 80          | 56          | 31          | 7           |
| 44 | 255         | 230         | 204         | 179         | 154         | 129         | 104         | 80          | 55          | 31          | 6           |
| 45 | 255         | 229         | 204         | 179         | 153         | 129         | 104         | 79          | 55          | 30          | 6           |
| 46 | 254         | 229         | 203         | 178         | 153         | 128         | 103         | 79          | 54          | 30          | 5           |
| 47 | 254         | 228         | 203         | 178         | 153         | 128         | 103         | 78          | 54          | 29          | 5           |
| 48 | 253         | 228         | 202         | 177         | 152         | 127         | 103         | 78          | 53          | 29          | 5           |
| 49 | 253         | 227         | 202         | 177         | 152         | 127         | 102         | 77          | 53          | 29          | 4           |
| 50 | 0252        | 0227        | 0202        | 0176        | 0151        | 0126        | 0102        | 0077        | 0053        | 0028        | 0004        |
| 51 | 252         | 227         | 201         | 176         | 151         | 126         | 101         | 77          | 52          | 28          | 4           |
| 52 | 252         | 226         | 201         | 176         | 151         | 126         | 101         | 76          | 52          | 27          | 3           |
| 53 | 251         | 226         | 200         | 175         | 150         | 125         | 100         | 76          | 51          | 27          | 3           |
| 54 | 251         | 225         | 200         | 175         | 150         | 125         | 100         | 75          | 51          | 27          | 2           |
| 55 | 250         | 225         | 200         | 174         | 149         | 124         | 100         | 75          | 51          | 26          | 2           |
| 56 | 250         | 224         | 199         | 174         | 149         | 124         | 099         | 75          | 50          | 26          | 2           |
| 57 | 250         | 224         | 199         | 174         | 148         | 124         | 099         | 74          | 50          | 25          | 1           |
| 58 | 249         | 224         | 198         | 173         | 148         | 123         | 098         | 74          | 49          | 25          | 1           |
| 59 | 249         | 223         | 198         | 173         | 148         | 123         | 098         | 73          | 49          | 25          | 0           |
| 60 | 0248        | 0223        | 0197        | 0172        | 0148        | 0122        | 0098        | 0073        | 0049        | 0024        | 0000        |

TABLE X.

| Parallax in Altitude or Distance | Add |
|----------------------------------|-----|
| 10°                              | 1   |
| "                                | 3   |
| M                                | 5   |
| 5                                | 8   |
| 8                                | 3   |
| 10                               | 5   |
| 11                               | 6   |
| 12                               | 7   |
| 13                               | 8   |
| 14                               | 10  |
| 15                               | 11  |
| 16                               | 13  |
| 17                               | 14  |
| 18                               | 16  |
| 19                               | 18  |
| 20                               | 20  |
| 21                               | 22  |
| 22                               | 24  |
| 23                               | 26  |
| 24                               | 29  |
| 25                               | 31  |
| 26                               | 34  |
| 27                               | 36  |
| 28                               | 39  |
| 29                               | 42  |
| 30                               | 45  |
| 31                               | 48  |
| 32                               | 51  |
| 33                               | 54  |
| 34                               | 57  |
| 35                               | 60  |
| 36                               | 64  |
| 37                               | 67  |
| 38                               | 71  |
| 39                               | 75  |
| 40                               | 79  |
| 41                               | 83  |
| 42                               | 87  |
| 43                               | 91  |
| 44                               | 96  |
| 45                               | 100 |
| 46                               | 105 |
| 47                               | 109 |
| 48                               | 114 |
| 49                               | 119 |
| 50                               | 124 |
| 51                               | 129 |
| 52                               | 134 |
| 53                               | 139 |
| 54                               | 144 |
| 55                               | 149 |
| 56                               | 155 |
| 57                               | 160 |
| 58                               | 166 |
| 59                               | 172 |
| 60                               | 178 |
| 61                               | 184 |
| 62                               | 190 |

TABLE X. For computing the Effects of Parallax on the MOON'S Distance from the SUN or a STAR.

Apparent Distance.

Add the Difference of the two Numbers taken out of this Table, if the Apparent Distance is less than  $90^{\circ}$ , and subtract it if above.

|    | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | 20° | 21° | 22° | 23° | 24° | 25° |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| M  | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   |
| 1  | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 2  | 3   | 3   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 1   | 1   | 1   | 1   | 1   | 1   |
| 3  | 5   | 5   | 4   | 4   | 4   | 3   | 3   | 3   | 3   | 2   | 2   | 2   | 2   | 2   | 2   | 2   |
| 4  | 6   | 5   | 5   | 4   | 4   | 4   | 4   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 2   | 2   |
| 5  | 7   | 6   | 6   | 5   | 5   | 4   | 4   | 4   | 4   | 3   | 3   | 3   | 3   | 3   | 3   | 3   |
| 6  | 8   | 8   | 7   | 6   | 6   | 5   | 5   | 5   | 5   | 4   | 4   | 4   | 4   | 3   | 3   | 3   |
| 7  | 10  | 9   | 8   | 7   | 7   | 6   | 6   | 6   | 6   | 5   | 5   | 4   | 4   | 4   | 4   | 4   |
| 8  | 11  | 10  | 9   | 8   | 8   | 7   | 7   | 6   | 6   | 5   | 5   | 5   | 5   | 4   | 4   | 4   |
| 9  | 13  | 11  | 10  | 9   | 9   | 8   | 8   | 7   | 7   | 6   | 6   | 6   | 6   | 5   | 5   | 5   |
| 10 | 14  | 13  | 12  | 11  | 10  | 9   | 9   | 8   | 8   | 7   | 7   | 6   | 6   | 6   | 5   | 5   |
| 11 | 16  | 14  | 13  | 12  | 11  | 10  | 10  | 9   | 9   | 8   | 8   | 7   | 7   | 6   | 6   | 6   |
| 12 | 18  | 16  | 15  | 14  | 13  | 12  | 11  | 10  | 10  | 9   | 8   | 8   | 8   | 7   | 7   | 7   |
| 13 | 20  | 18  | 16  | 15  | 14  | 13  | 12  | 11  | 11  | 10  | 9   | 9   | 9   | 8   | 8   | 7   |
| 14 | 22  | 20  | 18  | 17  | 15  | 14  | 13  | 12  | 12  | 11  | 10  | 10  | 10  | 9   | 9   | 8   |
| 15 | 24  | 22  | 20  | 18  | 17  | 16  | 15  | 14  | 13  | 12  | 12  | 11  | 11  | 10  | 10  | 9   |
| 16 | 26  | 24  | 22  | 20  | 18  | 17  | 16  | 15  | 14  | 13  | 13  | 12  | 11  | 11  | 10  | 10  |
| 17 | 29  | 26  | 24  | 22  | 20  | 19  | 18  | 17  | 16  | 15  | 14  | 13  | 12  | 11  | 11  | 10  |
| 18 | 31  | 28  | 26  | 24  | 22  | 21  | 19  | 18  | 17  | 16  | 15  | 14  | 13  | 12  | 12  | 11  |
| 19 | 34  | 31  | 28  | 26  | 24  | 22  | 21  | 19  | 18  | 17  | 16  | 15  | 14  | 13  | 13  | 12  |
| 20 | 36  | 33  | 30  | 28  | 26  | 24  | 22  | 21  | 19  | 18  | 17  | 16  | 15  | 15  | 14  | 13  |
| 21 | 39  | 35  | 32  | 30  | 28  | 26  | 24  | 22  | 21  | 20  | 19  | 18  | 17  | 16  | 15  | 14  |
| 22 | 42  | 38  | 34  | 32  | 30  | 28  | 25  | 24  | 22  | 21  | 20  | 19  | 18  | 17  | 16  | 15  |
| 23 | 45  | 41  | 37  | 34  | 32  | 29  | 27  | 25  | 24  | 22  | 21  | 20  | 19  | 18  | 17  | 16  |
| 24 | 48  | 44  | 39  | 37  | 34  | 31  | 29  | 27  | 25  | 24  | 23  | 22  | 21  | 19  | 18  | 18  |
| 25 | 51  | 46  | 42  | 39  | 36  | 33  | 31  | 29  | 27  | 25  | 24  | 23  | 22  | 21  | 20  | 19  |
| 26 | 54  | 49  | 44  | 41  | 38  | 35  | 33  | 31  | 29  | 27  | 25  | 24  | 23  | 22  | 21  | 20  |
| 27 | 57  | 52  | 47  | 44  | 41  | 38  | 35  | 33  | 31  | 29  | 27  | 25  | 24  | 23  | 22  | 21  |
| 28 | 60  | 55  | 50  | 46  | 43  | 40  | 37  | 35  | 33  | 31  | 29  | 27  | 25  | 24  | 23  | 23  |
| 29 | 64  | 58  | 53  | 49  | 45  | 42  | 40  | 37  | 35  | 33  | 31  | 29  | 27  | 26  | 25  | 24  |
| 30 | 67  | 61  | 56  | 52  | 48  | 45  | 42  | 39  | 37  | 35  | 32  | 31  | 29  | 28  | 26  | 25  |
| 31 | 71  | 65  | 59  | 55  | 51  | 47  | 44  | 41  | 39  | 36  | 34  | 32  | 31  | 29  | 28  | 27  |
| 32 | 75  | 68  | 62  | 58  | 53  | 50  | 46  | 43  | 41  | 38  | 36  | 34  | 32  | 31  | 29  | 28  |
| 33 | 79  | 72  | 66  | 61  | 56  | 52  | 49  | 46  | 43  | 40  | 38  | 36  | 34  | 32  | 31  | 30  |
| 34 | 83  | 76  | 69  | 64  | 59  | 55  | 51  | 48  | 45  | 42  | 40  | 38  | 36  | 34  | 33  | 32  |
| 35 | 87  | 80  | 73  | 67  | 62  | 58  | 54  | 50  | 47  | 44  | 42  | 40  | 38  | 36  | 35  | 33  |
| 36 | 91  | 84  | 76  | 70  | 64  | 60  | 56  | 53  | 49  | 47  | 44  | 42  | 39  | 38  | 36  | 35  |
| 37 | 96  | 88  | 80  | 73  | 67  | 63  | 59  | 55  | 52  | 49  | 46  | 43  | 41  | 39  | 38  | 36  |
| 38 | 100 | 92  | 83  | 77  | 70  | 66  | 61  | 58  | 54  | 51  | 48  | 46  | 43  | 41  | 40  | 38  |
| 39 | 105 | 96  | 87  | 80  | 74  | 69  | 64  | 60  | 57  | 54  | 51  | 48  | 45  | 43  | 42  | 40  |
| 40 | 109 | 100 | 91  | 84  | 77  | 72  | 67  | 63  | 59  | 56  | 53  | 49  | 47  | 45  | 43  | 42  |
| 41 | 114 | 104 | 95  | 87  | 80  | 75  | 70  | 65  | 61  | 58  | 55  | 52  | 50  | 47  | 45  | 43  |
| 42 | 119 | 109 | 99  | 91  | 83  | 78  | 73  | 69  | 64  | 61  | 57  | 55  | 52  | 49  | 46  | 45  |
| 43 | 124 | 113 | 103 | 95  | 87  | 81  | 76  | 71  | 67  | 63  | 60  | 57  | 54  | 51  | 48  | 46  |
| 44 | 129 | 117 | 107 | 98  | 91  | 85  | 79  | 74  | 69  | 66  | 62  | 59  | 56  | 53  | 50  | 49  |
| 45 | 134 | 121 | 111 | 102 | 95  | 89  | 83  | 77  | 72  | 68  | 65  | 61  | 58  | 55  | 53  | 51  |
| 46 | 139 | 126 | 115 | 106 | 98  | 92  | 86  | 80  | 74  | 71  | 67  | 64  | 60  | 58  | 55  | 53  |
| 47 | 144 | 131 | 120 | 110 | 102 | 95  | 89  | 83  | 77  | 73  | 70  | 66  | 63  | 60  | 57  | 54  |
| 48 | 149 | 136 | 124 | 114 | 106 | 99  | 92  | 86  | 80  | 76  | 72  | 69  | 65  | 62  | 59  | 57  |
| 49 | 155 | 141 | 129 | 119 | 110 | 103 | 96  | 89  | 83  | 79  | 75  | 71  | 68  | 65  | 62  | 59  |
| 50 | 160 | 146 | 133 | 123 | 114 | 107 | 99  | 93  | 86  | 82  | 77  | 74  | 70  | 67  | 64  | 61  |
| 51 | 166 | 151 | 138 | 127 | 118 | 110 | 103 | 96  | 90  | 85  | 80  | 76  | 73  | 69  | 66  | 63  |
| 52 | 172 | 156 | 143 | 133 | 123 | 115 | 106 | 100 | 93  | 88  | 83  | 79  | 75  | 72  | 68  | 65  |
| 53 | 178 | 162 | 148 | 137 | 128 | 119 | 110 | 103 | 97  | 91  | 86  | 82  | 78  | 74  | 70  | 67  |
| 54 | 184 | 167 | 153 | 141 | 131 | 122 | 113 | 107 | 100 | 94  | 89  | 85  | 80  | 76  | 72  | 69  |
| 55 | 190 | 173 | 158 | 145 | 135 | 125 | 117 | 110 | 103 | 97  | 92  | 87  | 83  | 79  | 75  | 72  |



TABLE X. For computing the Effects of Parallax on the Moon's Distance from the SUN or a STAR.

| Parallax in Altitude or Distance | Apparent Distance.                                                                                                                  |     |     |     |     |     |     |     |     |     |     |     |     |   |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|
|                                  | Add the Difference of the two Numbers taken out of this Table, if the Apparent Distance is less than 90°, and subtract it if above. |     |     |     |     |     |     |     |     |     |     |     |     |   |
|                                  | 26°                                                                                                                                 | 27° | 28° | 29° | 30° | 31° | 32° | 33° | 34° | 35° | 36° | 37° | 38° |   |
| M                                | "                                                                                                                                   | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   | " |
| 5                                | 0                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |   |
| 8                                | 1                                                                                                                                   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 0   | 0   |   |
| 10                               | 2                                                                                                                                   | 2   | 2   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   |   |
| 11                               | 2                                                                                                                                   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 1   | 1   | 1   | 1   | 1   |   |
| 12                               | 3                                                                                                                                   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 1   | 1   |   |
| 13                               | 3                                                                                                                                   | 3   | 3   | 3   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   |   |
| 14                               | 4                                                                                                                                   | 3   | 3   | 3   | 3   | 3   | 3   | 2   | 2   | 2   | 2   | 2   | 2   |   |
| 15                               | 4                                                                                                                                   | 4   | 4   | 4   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 2   | 2   |   |
| 16                               | 5                                                                                                                                   | 5   | 5   | 4   | 4   | 4   | 4   | 3   | 3   | 3   | 3   | 2   | 2   |   |
| 17                               | 5                                                                                                                                   | 5   | 5   | 5   | 4   | 4   | 4   | 4   | 4   | 4   | 3   | 3   | 3   |   |
| 18                               | 6                                                                                                                                   | 6   | 6   | 5   | 5   | 5   | 5   | 4   | 4   | 4   | 4   | 3   | 3   |   |
| 19                               | 6                                                                                                                                   | 6   | 6   | 6   | 5   | 5   | 5   | 5   | 5   | 4   | 4   | 4   | 4   |   |
| 20                               | 7                                                                                                                                   | 7   | 7   | 6   | 6   | 6   | 6   | 5   | 5   | 5   | 5   | 4   | 4   |   |
| 21                               | 8                                                                                                                                   | 7   | 7   | 7   | 7   | 6   | 6   | 6   | 6   | 5   | 5   | 5   | 5   |   |
| 22                               | 9                                                                                                                                   | 8   | 8   | 7   | 7   | 7   | 7   | 6   | 6   | 6   | 6   | 5   | 5   |   |
| 23                               | 9                                                                                                                                   | 9   | 9   | 8   | 8   | 7   | 7   | 7   | 7   | 6   | 6   | 6   | 6   |   |
| 24                               | 10                                                                                                                                  | 9   | 9   | 9   | 9   | 8   | 8   | 7   | 7   | 7   | 7   | 6   | 6   |   |
| 25                               | 11                                                                                                                                  | 10  | 10  | 10  | 9   | 9   | 9   | 8   | 8   | 8   | 7   | 7   | 7   |   |
| 26                               | 12                                                                                                                                  | 11  | 11  | 10  | 10  | 9   | 9   | 9   | 9   | 8   | 8   | 7   | 7   |   |
| 27                               | 13                                                                                                                                  | 12  | 12  | 11  | 11  | 10  | 10  | 10  | 9   | 9   | 9   | 8   | 8   |   |
| 28                               | 14                                                                                                                                  | 13  | 13  | 12  | 12  | 11  | 11  | 10  | 10  | 9   | 9   | 8   | 8   |   |
| 29                               | 15                                                                                                                                  | 14  | 14  | 13  | 13  | 12  | 12  | 11  | 11  | 10  | 10  | 9   | 9   |   |
| 30                               | 16                                                                                                                                  | 15  | 15  | 14  | 14  | 13  | 13  | 12  | 12  | 11  | 11  | 10  | 10  |   |
| 31                               | 17                                                                                                                                  | 16  | 16  | 15  | 15  | 14  | 14  | 13  | 13  | 12  | 11  | 11  | 11  |   |
| 32                               | 18                                                                                                                                  | 17  | 17  | 16  | 16  | 15  | 15  | 14  | 14  | 13  | 12  | 11  | 11  |   |
| 33                               | 19                                                                                                                                  | 19  | 18  | 17  | 17  | 16  | 16  | 15  | 14  | 14  | 13  | 12  | 12  |   |
| 34                               | 21                                                                                                                                  | 20  | 19  | 18  | 18  | 17  | 17  | 16  | 15  | 14  | 14  | 13  | 13  |   |
| 35                               | 22                                                                                                                                  | 21  | 20  | 19  | 19  | 18  | 17  | 17  | 16  | 15  | 14  | 14  | 13  |   |
| 36                               | 23                                                                                                                                  | 22  | 21  | 20  | 20  | 19  | 18  | 17  | 17  | 16  | 15  | 14  | 14  |   |
| 37                               | 24                                                                                                                                  | 23  | 22  | 21  | 21  | 20  | 19  | 18  | 18  | 17  | 16  | 15  | 15  |   |
| 38                               | 26                                                                                                                                  | 24  | 23  | 22  | 22  | 21  | 20  | 19  | 19  | 18  | 17  | 16  | 16  |   |
| 39                               | 27                                                                                                                                  | 26  | 24  | 24  | 23  | 22  | 21  | 20  | 20  | 19  | 18  | 17  | 17  |   |
| 40                               | 29                                                                                                                                  | 27  | 26  | 25  | 24  | 23  | 22  | 21  | 21  | 20  | 19  | 18  | 18  |   |
| 41                               | 30                                                                                                                                  | 29  | 27  | 26  | 25  | 24  | 23  | 23  | 22  | 21  | 20  | 19  | 19  |   |
| 42                               | 32                                                                                                                                  | 30  | 29  | 28  | 27  | 26  | 25  | 24  | 23  | 22  | 21  | 20  | 20  |   |
| 43                               | 33                                                                                                                                  | 32  | 30  | 29  | 28  | 27  | 26  | 25  | 24  | 23  | 22  | 21  | 21  |   |
| 44                               | 35                                                                                                                                  | 33  | 32  | 30  | 29  | 28  | 27  | 26  | 25  | 24  | 23  | 22  | 22  |   |
| 45                               | 36                                                                                                                                  | 35  | 33  | 32  | 30  | 29  | 28  | 27  | 26  | 25  | 24  | 23  | 23  |   |
| 46                               | 38                                                                                                                                  | 36  | 35  | 33  | 32  | 30  | 29  | 28  | 27  | 26  | 25  | 24  | 24  |   |
| 47                               | 40                                                                                                                                  | 38  | 36  | 35  | 33  | 32  | 30  | 29  | 28  | 27  | 26  | 26  | 25  |   |
| 48                               | 42                                                                                                                                  | 40  | 38  | 36  | 35  | 33  | 32  | 31  | 30  | 29  | 28  | 27  | 26  |   |
| 49                               | 43                                                                                                                                  | 41  | 39  | 38  | 36  | 35  | 33  | 32  | 31  | 30  | 29  | 28  | 27  |   |
| 50                               | 45                                                                                                                                  | 43  | 41  | 39  | 38  | 36  | 35  | 33  | 32  | 31  | 30  | 29  | 28  |   |
| 51                               | 47                                                                                                                                  | 45  | 43  | 41  | 39  | 38  | 36  | 35  | 33  | 32  | 31  | 30  | 29  |   |
| 52                               | 49                                                                                                                                  | 47  | 45  | 43  | 41  | 39  | 38  | 36  | 35  | 33  | 32  | 31  | 30  |   |
| 53                               | 50                                                                                                                                  | 48  | 46  | 44  | 42  | 41  | 39  | 38  | 36  | 35  | 33  | 32  | 31  |   |
| 54                               | 52                                                                                                                                  | 50  | 48  | 46  | 44  | 42  | 41  | 39  | 38  | 36  | 35  | 33  | 32  |   |
| 55                               | 54                                                                                                                                  | 52  | 49  | 47  | 45  | 44  | 42  | 41  | 39  | 38  | 36  | 35  | 33  |   |
| 56                               | 56                                                                                                                                  | 53  | 51  | 49  | 47  | 45  | 44  | 42  | 41  | 39  | 38  | 36  | 35  |   |
| 57                               | 58                                                                                                                                  | 55  | 53  | 51  | 49  | 47  | 45  | 44  | 42  | 41  | 39  | 37  | 36  |   |
| 58                               | 60                                                                                                                                  | 57  | 55  | 53  | 51  | 49  | 47  | 45  | 44  | 42  | 40  | 38  | 37  |   |
| 59                               | 62                                                                                                                                  | 59  | 57  | 55  | 53  | 51  | 48  | 47  | 45  | 43  | 41  | 40  | 38  |   |
| 60                               | 64                                                                                                                                  | 61  | 59  | 56  | 54  | 52  | 50  | 48  | 47  | 45  | 43  | 41  | 40  |   |
| 61                               | 66                                                                                                                                  | 63  | 61  | 58  | 56  | 54  | 52  | 50  | 48  | 46  | 44  | 43  | 41  |   |
| 62                               | 69                                                                                                                                  | 66  | 63  | 60  | 58  | 56  | 54  | 52  | 50  | 48  | 46  | 44  | 43  |   |

TABLE X. For computing the Effects of Parallax on the MOON'S Distance from the SUN or a STAR.

| Apparent Distance.                                                                                                                  |     |     |     |     |     |     |     |     |     |     |     |     |     |    |
|-------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|
| Add the Difference of the two Numbers taken out of this Table, if the Apparent Distance is less than 90°, and subtract it if above. |     |     |     |     |     |     |     |     |     |     |     |     |     |    |
| Parallax in Altitude of Distance                                                                                                    | 39° | 40° | 41° | 42° | 43° | 44° | 45° | 46° | 47° | 48° | 49° | 50° | 51° |    |
| M                                                                                                                                   | //  | //  | //  | //  | //  | //  | //  | //  | //  | //  | //  | //  | //  | // |
| 5                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0  |
| 8                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0  |
| 10                                                                                                                                  | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 0  |
| 11                                                                                                                                  | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 0  |
| 12                                                                                                                                  | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 0  |
| 13                                                                                                                                  | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 1   | 1   | 1  |
| 14                                                                                                                                  | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 1   | 1   | 1  |
| 15                                                                                                                                  | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 1   | 1   | 1  |
| 16                                                                                                                                  | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 1  |
| 17                                                                                                                                  | 3   | 3   | 3   | 3   | 3   | 3   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2  |
| 18                                                                                                                                  | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 2   | 2   | 2   | 2   | 2  |
| 19                                                                                                                                  | 4   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3  |
| 20                                                                                                                                  | 4   | 4   | 4   | 4   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3  |
| 21                                                                                                                                  | 5   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 3   | 3   | 3   | 3   | 3  |
| 22                                                                                                                                  | 5   | 5   | 5   | 5   | 4   | 4   | 4   | 4   | 4   | 3   | 3   | 3   | 3   | 3  |
| 23                                                                                                                                  | 6   | 5   | 5   | 5   | 5   | 5   | 4   | 4   | 4   | 4   | 4   | 4   | 3   | 3  |
| 24                                                                                                                                  | 6   | 6   | 6   | 6   | 5   | 5   | 5   | 5   | 5   | 4   | 4   | 4   | 4   | 4  |
| 25                                                                                                                                  | 7   | 6   | 6   | 6   | 6   | 6   | 5   | 5   | 5   | 5   | 5   | 4   | 4   | 4  |
| 26                                                                                                                                  | 7   | 7   | 7   | 7   | 6   | 6   | 6   | 6   | 6   | 5   | 5   | 5   | 5   | 5  |
| 27                                                                                                                                  | 8   | 7   | 7   | 7   | 7   | 6   | 6   | 6   | 6   | 5   | 5   | 5   | 5   | 5  |
| 28                                                                                                                                  | 8   | 8   | 8   | 8   | 7   | 7   | 7   | 7   | 7   | 6   | 6   | 6   | 6   | 6  |
| 29                                                                                                                                  | 9   | 9   | 9   | 8   | 8   | 7   | 7   | 7   | 7   | 6   | 6   | 6   | 6   | 6  |
| 30                                                                                                                                  | 9   | 9   | 9   | 9   | 8   | 8   | 8   | 8   | 7   | 7   | 6   | 6   | 6   | 6  |
| 31                                                                                                                                  | 10  | 10  | 10  | 9   | 9   | 8   | 8   | 8   | 8   | 7   | 7   | 7   | 6   | 6  |
| 32                                                                                                                                  | 10  | 10  | 10  | 10  | 9   | 9   | 9   | 9   | 8   | 8   | 7   | 7   | 6   | 6  |
| 33                                                                                                                                  | 11  | 11  | 11  | 10  | 10  | 10  | 9   | 9   | 8   | 8   | 7   | 7   | 7   | 7  |
| 34                                                                                                                                  | 12  | 11  | 11  | 11  | 10  | 10  | 10  | 10  | 9   | 9   | 8   | 8   | 7   | 7  |
| 35                                                                                                                                  | 13  | 12  | 12  | 11  | 11  | 11  | 10  | 10  | 9   | 9   | 8   | 8   | 8   | 8  |
| 36                                                                                                                                  | 13  | 13  | 13  | 12  | 11  | 11  | 11  | 11  | 10  | 10  | 9   | 9   | 9   | 9  |
| 37                                                                                                                                  | 14  | 13  | 13  | 12  | 12  | 11  | 11  | 11  | 10  | 10  | 10  | 10  | 10  | 10 |
| 38                                                                                                                                  | 15  | 14  | 14  | 13  | 13  | 12  | 12  | 12  | 12  | 11  | 11  | 11  | 11  | 11 |
| 39                                                                                                                                  | 16  | 15  | 15  | 14  | 14  | 13  | 13  | 13  | 13  | 12  | 12  | 12  | 12  | 12 |
| 40                                                                                                                                  | 17  | 16  | 16  | 15  | 15  | 14  | 14  | 14  | 13  | 13  | 12  | 12  | 12  | 12 |
| 41                                                                                                                                  | 18  | 17  | 17  | 16  | 15  | 15  | 14  | 14  | 14  | 13  | 13  | 12  | 12  | 12 |
| 42                                                                                                                                  | 19  | 18  | 18  | 17  | 16  | 15  | 15  | 15  | 14  | 14  | 13  | 13  | 13  | 13 |
| 43                                                                                                                                  | 20  | 18  | 18  | 17  | 16  | 16  | 15  | 15  | 14  | 14  | 13  | 13  | 13  | 13 |
| 44                                                                                                                                  | 20  | 19  | 19  | 18  | 17  | 16  | 16  | 16  | 15  | 15  | 14  | 13  | 13  | 13 |
| 45                                                                                                                                  | 21  | 20  | 20  | 19  | 18  | 17  | 17  | 16  | 15  | 15  | 14  | 14  | 14  | 14 |
| 46                                                                                                                                  | 22  | 21  | 20  | 20  | 19  | 18  | 18  | 17  | 16  | 16  | 15  | 14  | 14  | 14 |
| 47                                                                                                                                  | 23  | 22  | 22  | 21  | 20  | 20  | 19  | 18  | 17  | 16  | 15  | 15  | 15  | 15 |
| 48                                                                                                                                  | 24  | 23  | 23  | 22  | 22  | 21  | 20  | 19  | 18  | 17  | 16  | 16  | 16  | 16 |
| 49                                                                                                                                  | 26  | 24  | 24  | 24  | 23  | 22  | 21  | 20  | 19  | 18  | 17  | 17  | 17  | 17 |
| 50                                                                                                                                  | 27  | 26  | 26  | 25  | 24  | 23  | 22  | 21  | 20  | 19  | 18  | 18  | 18  | 18 |
| 51                                                                                                                                  | 28  | 27  | 26  | 25  | 24  | 23  | 22  | 22  | 21  | 20  | 19  | 18  | 18  | 18 |
| 52                                                                                                                                  | 29  | 28  | 27  | 26  | 25  | 24  | 23  | 22  | 21  | 20  | 19  | 19  | 19  | 18 |
| 53                                                                                                                                  | 30  | 29  | 28  | 27  | 26  | 25  | 24  | 23  | 22  | 21  | 20  | 19  | 19  | 19 |
| 54                                                                                                                                  | 31  | 30  | 29  | 28  | 27  | 26  | 25  | 24  | 23  | 22  | 21  | 20  | 19  | 19 |
| 55                                                                                                                                  | 32  | 31  | 30  | 29  | 28  | 27  | 26  | 25  | 24  | 23  | 22  | 21  | 20  | 20 |
| 56                                                                                                                                  | 33  | 32  | 31  | 30  | 29  | 28  | 27  | 26  | 25  | 24  | 23  | 22  | 21  | 21 |
| 57                                                                                                                                  | 35  | 33  | 32  | 31  | 30  | 29  | 28  | 27  | 26  | 25  | 24  | 23  | 22  | 22 |
| 58                                                                                                                                  | 36  | 35  | 33  | 32  | 31  | 30  | 29  | 28  | 27  | 26  | 25  | 24  | 23  | 23 |
| 59                                                                                                                                  | 37  | 36  | 34  | 33  | 32  | 31  | 30  | 29  | 28  | 27  | 26  | 25  | 24  | 24 |
| 60                                                                                                                                  | 38  | 37  | 35  | 34  | 33  | 32  | 31  | 30  | 29  | 28  | 27  | 26  | 25  | 25 |
| 61                                                                                                                                  | 40  | 38  | 36  | 35  | 34  | 33  | 32  | 31  | 30  | 29  | 28  | 27  | 26  | 26 |
| 62                                                                                                                                  | 41  | 40  | 38  | 36  | 35  | 34  | 33  | 32  | 31  | 30  | 29  | 28  | 27  | 27 |

TABLE X. For computing the Effects of Parallax on the Moon's Distance from the SUN or a STAR.

| Parallax in Altitude or Distance | Apparent Distance.                                                                                                                  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                                  | Add the Difference of the two Numbers taken out of this Table, if the Apparent Distance is less than 90°, and subtract it if above. |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|                                  | 52°                                                                                                                                 | 53° | 54° | 55° | 56° | 57° | 58° | 59° | 60° | 65° | 70° | 75° | 80° | 85° | 90° |
| M                                | "                                                                                                                                   | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   | "   |
| 1                                | 0                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 2                                | 0                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 3                                | 0                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 4                                | 0                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 5                                | 0                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 6                                | 0                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 7                                | 0                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 8                                | 0                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 9                                | 0                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 10                               | 0                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 11                               | 0                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 12                               | 0                                                                                                                                   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 13                               | 1                                                                                                                                   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   |
| 14                               | 1                                                                                                                                   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   |
| 15                               | 1                                                                                                                                   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   |
| 16                               | 1                                                                                                                                   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   |
| 17                               | 2                                                                                                                                   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   |
| 18                               | 2                                                                                                                                   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   |
| 19                               | 3                                                                                                                                   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   |
| 20                               | 3                                                                                                                                   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   |
| 21                               | 3                                                                                                                                   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   |
| 22                               | 3                                                                                                                                   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   |
| 23                               | 3                                                                                                                                   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   |
| 24                               | 4                                                                                                                                   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   |
| 25                               | 4                                                                                                                                   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   |
| 26                               | 5                                                                                                                                   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   |
| 27                               | 5                                                                                                                                   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   | 5   |
| 28                               | 6                                                                                                                                   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   |
| 29                               | 6                                                                                                                                   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   |
| 30                               | 6                                                                                                                                   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   |
| 31                               | 6                                                                                                                                   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   |
| 32                               | 6                                                                                                                                   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   |
| 33                               | 6                                                                                                                                   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   | 6   |
| 34                               | 7                                                                                                                                   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   |
| 35                               | 7                                                                                                                                   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   | 7   |
| 36                               | 8                                                                                                                                   | 8   | 8   | 8   | 8   | 8   | 8   | 8   | 8   | 8   | 8   | 8   | 8   | 8   | 8   |
| 37                               | 8                                                                                                                                   | 8   | 8   | 8   | 8   | 8   | 8   | 8   | 8   | 8   | 8   | 8   | 8   | 8   | 8   |
| 38                               | 9                                                                                                                                   | 9   | 9   | 9   | 9   | 9   | 9   | 9   | 9   | 9   | 9   | 9   | 9   | 9   | 9   |
| 39                               | 10                                                                                                                                  | 10  | 10  | 10  | 10  | 10  | 10  | 10  | 10  | 10  | 10  | 10  | 10  | 10  | 10  |
| 40                               | 11                                                                                                                                  | 11  | 11  | 11  | 11  | 11  | 11  | 11  | 11  | 11  | 11  | 11  | 11  | 11  | 11  |
| 41                               | 12                                                                                                                                  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  |
| 42                               | 12                                                                                                                                  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  |
| 43                               | 12                                                                                                                                  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  |
| 44                               | 12                                                                                                                                  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  | 12  |
| 45                               | 13                                                                                                                                  | 13  | 13  | 13  | 13  | 13  | 13  | 13  | 13  | 13  | 13  | 13  | 13  | 13  | 13  |
| 46                               | 13                                                                                                                                  | 13  | 13  | 13  | 13  | 13  | 13  | 13  | 13  | 13  | 13  | 13  | 13  | 13  | 13  |
| 47                               | 14                                                                                                                                  | 14  | 14  | 14  | 14  | 14  | 14  | 14  | 14  | 14  | 14  | 14  | 14  | 14  | 14  |
| 48                               | 15                                                                                                                                  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  |
| 49                               | 16                                                                                                                                  | 16  | 16  | 16  | 16  | 16  | 16  | 16  | 16  | 16  | 16  | 16  | 16  | 16  | 16  |
| 50                               | 17                                                                                                                                  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  |
| 51                               | 17                                                                                                                                  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  |
| 52                               | 17                                                                                                                                  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  | 17  |
| 53                               | 18                                                                                                                                  | 18  | 18  | 18  | 18  | 18  | 18  | 18  | 18  | 18  | 18  | 18  | 18  | 18  | 18  |
| 54                               | 19                                                                                                                                  | 19  | 19  | 19  | 19  | 19  | 19  | 19  | 19  | 19  | 19  | 19  | 19  | 19  | 19  |
| 55                               | 19                                                                                                                                  | 19  | 19  | 19  | 19  | 19  | 19  | 19  | 19  | 19  | 19  | 19  | 19  | 19  | 19  |
| 56                               | 20                                                                                                                                  | 20  | 20  | 20  | 20  | 20  | 20  | 20  | 20  | 20  | 20  | 20  | 20  | 20  | 20  |
| 57                               | 21                                                                                                                                  | 21  | 21  | 21  | 21  | 21  | 21  | 21  | 21  | 21  | 21  | 21  | 21  | 21  | 21  |
| 58                               | 22                                                                                                                                  | 22  | 22  | 22  | 22  | 22  | 22  | 22  | 22  | 22  | 22  | 22  | 22  | 22  | 22  |
| 59                               | 23                                                                                                                                  | 23  | 23  | 23  | 23  | 23  | 23  | 23  | 23  | 23  | 23  | 23  | 23  | 23  | 23  |
| 60                               | 24                                                                                                                                  | 24  | 24  | 24  | 24  | 24  | 24  | 24  | 24  | 24  | 24  | 24  | 24  | 24  | 24  |
| 61                               | 25                                                                                                                                  | 25  | 25  | 25  | 25  | 25  | 25  | 25  | 25  | 25  | 25  | 25  | 25  | 25  | 25  |
| 62                               | 26                                                                                                                                  | 26  | 26  | 26  | 26  | 26  | 26  | 26  | 26  | 26  | 26  | 26  | 26  | 26  | 26  |

| For | D | M |
|-----|---|---|
| 1   |   |   |
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| 60  |   |   |



TABLE XI.

For turning Degrees and Minutes into Time, and the contrary.

| D  | H M   | D   | H M   | D   | H M    | D   | H M    | D   | H M    | D   | H M    |
|----|-------|-----|-------|-----|--------|-----|--------|-----|--------|-----|--------|
| M  | M S   | M   | M S   | M   | M S    | M   | D M    | M   | M S    | M   | M S    |
| 1  | 0. 4  | 61  | 4. 4  | 121 | 8. 4   | 181 | 12. 4  | 241 | 16. 4  | 301 | 20. 4  |
| 2  | 0. 8  | 62  | 4. 8  | 122 | 8. 8   | 182 | 12. 8  | 242 | 16. 8  | 302 | 20. 8  |
| 3  | 0. 12 | 63  | 4. 12 | 123 | 8. 12  | 183 | 12. 12 | 243 | 16. 12 | 303 | 20. 12 |
| 4  | 0. 16 | 64  | 4. 16 | 124 | 8. 16  | 184 | 12. 16 | 244 | 16. 16 | 304 | 20. 16 |
| 5  | 0. 20 | 65  | 4. 20 | 125 | 8. 20  | 185 | 12. 20 | 245 | 16. 20 | 305 | 20. 20 |
| 6  | 0. 24 | 66  | 4. 24 | 126 | 8. 24  | 186 | 12. 24 | 246 | 16. 24 | 306 | 20. 24 |
| 7  | 0. 28 | 67  | 4. 28 | 127 | 8. 28  | 187 | 12. 28 | 247 | 16. 28 | 307 | 20. 28 |
| 8  | 0. 32 | 68  | 4. 32 | 128 | 8. 32  | 188 | 12. 32 | 248 | 16. 32 | 308 | 20. 32 |
| 9  | 0. 36 | 69  | 4. 36 | 129 | 8. 36  | 189 | 12. 36 | 249 | 16. 36 | 309 | 20. 36 |
| 10 | 0. 40 | 70  | 4. 40 | 130 | 8. 40  | 190 | 12. 40 | 250 | 16. 40 | 310 | 20. 40 |
| 11 | 0. 44 | 71  | 4. 44 | 131 | 8. 44  | 191 | 12. 44 | 251 | 16. 44 | 311 | 20. 44 |
| 12 | 0. 48 | 72  | 4. 48 | 132 | 8. 48  | 192 | 12. 48 | 252 | 16. 48 | 312 | 20. 48 |
| 13 | 0. 52 | 73  | 4. 52 | 133 | 8. 52  | 193 | 12. 52 | 253 | 16. 52 | 313 | 20. 52 |
| 14 | 0. 56 | 74  | 4. 56 | 134 | 8. 56  | 194 | 12. 56 | 254 | 16. 56 | 314 | 20. 56 |
| 15 | 1. 0  | 75  | 5. 0  | 135 | 9. 0   | 195 | 13. 0  | 255 | 17. 0  | 315 | 21. 0  |
| 16 | 1. 4  | 76  | 5. 4  | 136 | 9. 4   | 196 | 13. 4  | 256 | 17. 4  | 316 | 21. 4  |
| 17 | 1. 8  | 77  | 5. 8  | 137 | 9. 8   | 197 | 13. 8  | 257 | 17. 8  | 317 | 21. 8  |
| 18 | 1. 12 | 78  | 5. 12 | 138 | 9. 12  | 198 | 13. 12 | 258 | 17. 12 | 318 | 21. 12 |
| 19 | 1. 16 | 79  | 5. 16 | 139 | 9. 16  | 199 | 13. 16 | 259 | 17. 16 | 319 | 21. 16 |
| 20 | 1. 20 | 80  | 5. 20 | 140 | 9. 20  | 200 | 13. 20 | 260 | 17. 20 | 320 | 21. 20 |
| 21 | 1. 24 | 81  | 5. 24 | 141 | 9. 24  | 201 | 13. 24 | 261 | 17. 24 | 321 | 21. 24 |
| 22 | 1. 28 | 82  | 5. 28 | 142 | 9. 28  | 202 | 13. 28 | 262 | 17. 28 | 322 | 21. 28 |
| 23 | 1. 32 | 83  | 5. 32 | 143 | 9. 32  | 203 | 13. 32 | 263 | 17. 32 | 323 | 21. 32 |
| 24 | 1. 36 | 84  | 5. 36 | 144 | 9. 36  | 204 | 13. 36 | 264 | 17. 36 | 324 | 21. 36 |
| 25 | 1. 40 | 85  | 5. 40 | 145 | 9. 40  | 205 | 13. 40 | 265 | 17. 40 | 325 | 21. 40 |
| 26 | 1. 44 | 86  | 5. 44 | 146 | 9. 44  | 206 | 13. 44 | 266 | 17. 44 | 326 | 21. 44 |
| 27 | 1. 48 | 87  | 5. 48 | 147 | 9. 48  | 207 | 13. 48 | 267 | 17. 48 | 327 | 21. 48 |
| 28 | 1. 52 | 88  | 5. 52 | 148 | 9. 52  | 208 | 13. 52 | 268 | 17. 52 | 328 | 21. 52 |
| 29 | 1. 56 | 89  | 5. 56 | 149 | 9. 56  | 209 | 13. 56 | 269 | 17. 56 | 329 | 21. 56 |
| 30 | 2. 0  | 90  | 6. 0  | 150 | 10. 0  | 210 | 14. 0  | 270 | 18. 0  | 330 | 22. 0  |
| 31 | 2. 4  | 91  | 6. 4  | 151 | 10. 4  | 211 | 14. 4  | 271 | 18. 4  | 331 | 22. 4  |
| 32 | 2. 8  | 92  | 6. 8  | 152 | 10. 8  | 212 | 14. 8  | 272 | 18. 8  | 332 | 22. 8  |
| 33 | 2. 12 | 93  | 6. 12 | 153 | 10. 12 | 213 | 14. 12 | 273 | 18. 12 | 333 | 22. 12 |
| 34 | 2. 16 | 94  | 6. 16 | 154 | 10. 16 | 214 | 14. 16 | 274 | 18. 16 | 334 | 22. 16 |
| 35 | 2. 20 | 95  | 6. 20 | 155 | 10. 20 | 215 | 14. 20 | 275 | 18. 20 | 335 | 22. 20 |
| 36 | 2. 24 | 96  | 6. 24 | 156 | 10. 24 | 216 | 14. 24 | 276 | 18. 24 | 336 | 22. 24 |
| 37 | 2. 28 | 97  | 6. 28 | 157 | 10. 28 | 217 | 14. 28 | 277 | 18. 28 | 337 | 22. 28 |
| 38 | 2. 32 | 98  | 6. 32 | 158 | 10. 32 | 218 | 14. 32 | 278 | 18. 32 | 338 | 22. 32 |
| 39 | 2. 36 | 99  | 6. 36 | 159 | 10. 36 | 219 | 14. 36 | 279 | 18. 36 | 339 | 22. 36 |
| 40 | 2. 40 | 100 | 6. 40 | 160 | 10. 40 | 220 | 14. 40 | 280 | 18. 40 | 340 | 22. 40 |
| 41 | 2. 44 | 101 | 6. 44 | 161 | 10. 44 | 221 | 14. 44 | 281 | 18. 44 | 341 | 22. 44 |
| 42 | 2. 48 | 102 | 6. 48 | 162 | 10. 48 | 222 | 14. 48 | 282 | 18. 48 | 342 | 22. 48 |
| 43 | 2. 52 | 103 | 6. 52 | 163 | 10. 52 | 223 | 14. 52 | 283 | 18. 52 | 343 | 22. 52 |
| 44 | 2. 56 | 104 | 6. 56 | 164 | 10. 56 | 224 | 14. 56 | 284 | 18. 56 | 344 | 22. 56 |
| 45 | 3. 0  | 105 | 7. 0  | 165 | 11. 0  | 225 | 15. 0  | 285 | 19. 0  | 345 | 23. 0  |
| 46 | 3. 4  | 106 | 7. 4  | 166 | 11. 4  | 226 | 15. 4  | 286 | 19. 4  | 346 | 23. 4  |
| 47 | 3. 8  | 107 | 7. 8  | 167 | 11. 8  | 227 | 15. 8  | 287 | 19. 8  | 347 | 23. 8  |
| 48 | 3. 12 | 108 | 7. 12 | 168 | 11. 12 | 228 | 15. 12 | 288 | 19. 12 | 348 | 23. 12 |
| 49 | 3. 16 | 109 | 7. 16 | 169 | 11. 16 | 229 | 15. 16 | 289 | 19. 16 | 349 | 23. 16 |
| 50 | 3. 20 | 110 | 7. 20 | 170 | 11. 20 | 230 | 15. 20 | 290 | 19. 20 | 350 | 23. 20 |
| 51 | 3. 24 | 111 | 7. 24 | 171 | 11. 24 | 231 | 15. 24 | 291 | 19. 24 | 351 | 23. 24 |
| 52 | 3. 28 | 112 | 7. 28 | 172 | 11. 28 | 232 | 15. 28 | 292 | 19. 28 | 352 | 23. 28 |
| 53 | 3. 32 | 113 | 7. 32 | 173 | 11. 32 | 233 | 15. 32 | 293 | 19. 32 | 353 | 23. 32 |
| 54 | 3. 36 | 114 | 7. 36 | 174 | 11. 36 | 234 | 15. 36 | 294 | 19. 36 | 354 | 23. 36 |
| 55 | 3. 40 | 115 | 7. 40 | 175 | 11. 40 | 235 | 15. 40 | 295 | 19. 40 | 355 | 23. 40 |
| 56 | 3. 44 | 116 | 7. 44 | 176 | 11. 44 | 236 | 15. 44 | 296 | 19. 44 | 356 | 23. 44 |
| 57 | 3. 48 | 117 | 7. 48 | 177 | 11. 48 | 237 | 15. 48 | 297 | 19. 48 | 357 | 23. 48 |
| 58 | 3. 52 | 118 | 7. 52 | 178 | 11. 52 | 238 | 15. 52 | 298 | 19. 52 | 358 | 23. 52 |
| 59 | 3. 56 | 119 | 7. 56 | 179 | 11. 56 | 239 | 15. 56 | 299 | 19. 56 | 359 | 23. 56 |
| 60 | 4. 0  | 120 | 8. 0  | 180 | 12. 0  | 240 | 16. 0  | 300 | 20. 0  | 360 | 24. 0  |

# TABLE XII. XIII. XIV. XV. XVI.

TABLE XII. The Refractions of the Heavenly Bodies in Altitude.

| App. Alt. | Ref.   | App. Alt. | Ref.  | App. Alt. | Ref.  |
|-----------|--------|-----------|-------|-----------|-------|
| D.M.      | M. S.  | D. M.     | M.S.  | D.        | M.S.  |
| 0. 0      | 33. 0  | 6. 30     | 7. 51 | 30        | 1. 38 |
| 0. 5      | 32. 10 | 6. 40     | 7. 40 | 31        | 1. 35 |
| 0. 10     | 31. 22 | 6. 50     | 7. 30 | 32        | 1. 31 |
| 0. 15     | 30. 35 | 7. 0      | 7. 20 | 33        | 1. 28 |
| 0. 20     | 29. 50 | 7. 10     | 7. 11 | 34        | 1. 24 |
| 0. 25     | 29. 6  | 7. 20     | 7. 2  | 35        | 1. 21 |
| 0. 30     | 28. 22 | 7. 30     | 6. 53 | 36        | 1. 18 |
| 0. 35     | 27. 41 | 7. 40     | 6. 45 | 37        | 1. 16 |
| 0. 40     | 27. 0  | 7. 50     | 6. 37 | 38        | 1. 13 |
| 0. 45     | 26. 20 | 8. 0      | 6. 29 | 39        | 1. 10 |
| 0. 50     | 25. 42 | 8. 10     | 6. 22 | 40        | 1. 8  |
| 0. 55     | 25. 5  | 8. 20     | 6. 15 | 41        | 1. 5  |
| 1. 0      | 24. 29 | 8. 30     | 6. 8  | 42        | 1. 3  |
| 1. 5      | 23. 54 | 8. 40     | 6. 1  | 43        | 1. 1  |
| 1. 10     | 23. 20 | 8. 50     | 5. 55 | 44        | 0. 59 |
| 1. 15     | 22. 47 | 9. 0      | 5. 48 | 45        | 0. 57 |
| 1. 20     | 22. 15 | 9. 10     | 5. 42 | 46        | 0. 55 |
| 1. 25     | 21. 44 | 9. 20     | 5. 36 | 47        | 0. 53 |
| 1. 30     | 21. 15 | 9. 30     | 5. 31 | 48        | 0. 51 |
| 1. 35     | 20. 46 | 9. 40     | 5. 25 | 49        | 0. 49 |
| 1. 40     | 20. 18 | 9. 50     | 5. 20 | 50        | 0. 48 |
| 1. 45     | 19. 51 | 10. 0     | 5. 15 | 51        | 0. 46 |
| 1. 50     | 19. 25 | 10. 15    | 5. 7  | 52        | 0. 44 |
| 1. 55     | 19. 0  | 10. 30    | 5. 0  | 53        | 0. 43 |
| 2. 0      | 18. 35 | 10. 45    | 4. 53 | 54        | 0. 41 |
| 2. 5      | 18. 11 | 11. 0     | 4. 47 | 55        | 0. 40 |
| 2. 10     | 17. 48 | 11. 15    | 4. 40 | 56        | 0. 38 |
| 2. 15     | 17. 26 | 11. 30    | 4. 34 | 57        | 0. 37 |
| 2. 20     | 17. 4  | 11. 45    | 4. 29 | 58        | 0. 35 |
| 2. 25     | 16. 44 | 12. 0     | 4. 23 | 59        | 0. 34 |
| 2. 30     | 16. 24 | 12. 20    | 4. 16 | 60        | 0. 33 |
| 2. 35     | 16. 4  | 12. 40    | 4. 9  | 61        | 0. 32 |
| 2. 40     | 15. 45 | 13. 0     | 4. 3  | 62        | 0. 30 |
| 2. 45     | 15. 27 | 13. 20    | 3. 57 | 63        | 0. 29 |
| 2. 50     | 15. 9  | 13. 40    | 3. 51 | 64        | 0. 28 |
| 2. 55     | 14. 52 | 14. 0     | 3. 45 | 65        | 0. 26 |
| 3. 0      | 14. 36 | 14. 20    | 3. 40 | 66        | 0. 25 |
| 3. 5      | 14. 20 | 14. 40    | 3. 35 | 67        | 0. 24 |
| 3. 10     | 14. 4  | 15. 0     | 3. 30 | 68        | 0. 23 |
| 3. 15     | 13. 49 | 15. 30    | 3. 24 | 69        | 0. 22 |
| 3. 20     | 13. 34 | 16. 0     | 3. 17 | 70        | 0. 21 |
| 3. 25     | 13. 20 | 16. 30    | 3. 10 | 71        | 0. 19 |
| 3. 30     | 13. 6  | 17. 0     | 3. 4  | 72        | 0. 18 |
| 3. 40     | 12. 40 | 17. 30    | 2. 59 | 73        | 0. 17 |
| 3. 50     | 12. 15 | 18. 0     | 2. 54 | 74        | 0. 16 |
| 4. 0      | 11. 51 | 18. 30    | 2. 49 | 75        | 0. 15 |
| 4. 10     | 11. 29 | 19. 0     | 2. 44 | 76        | 0. 14 |
| 4. 20     | 11. 8  | 19. 30    | 2. 39 | 77        | 0. 13 |
| 4. 30     | 10. 48 | 20. 0     | 2. 35 | 78        | 0. 12 |
| 4. 40     | 10. 29 | 20. 30    | 2. 31 | 79        | 0. 11 |
| 4. 50     | 10. 11 | 21. 0     | 2. 27 | 80        | 0. 10 |
| 5. 0      | 9. 54  | 21. 30    | 2. 24 | 81        | 0. 9  |
| 5. 10     | 9. 38  | 22. 0     | 2. 20 | 82        | 0. 8  |
| 5. 20     | 9. 23  | 23. 0     | 2. 14 | 83        | 0. 7  |
| 5. 30     | 9. 8   | 24. 0     | 2. 7  | 84        | 0. 6  |
| 5. 40     | 8. 54  | 25. 0     | 2. 2  | 85        | 0. 5  |
| 5. 50     | 8. 41  | 26. 0     | 1. 56 | 86        | 0. 4  |
| 6. 0      | 8. 28  | 27. 0     | 1. 51 | 87        | 0. 3  |
| 6. 10     | 8. 15  | 28. 0     | 1. 47 | 88        | 0. 2  |
| 6. 20     | 8. 3   | 29. 0     | 1. 42 | 89        | 0. 1  |

TABLE XIII. Depression or Dip of the Horizon of the Sea.

| Height of the Eye. | Dip of the Horizon. |
|--------------------|---------------------|
| Feet.              | M. S.               |
| 1                  | 0. 57               |
| 2                  | 1. 21               |
| 3                  | 1. 39               |
| 4                  | 1. 55               |
| 5                  | 2. 8                |
| 6                  | 2. 20               |
| 7                  | 2. 31               |
| 8                  | 2. 42               |
| 9                  | 2. 52               |
| 10                 | 3. 1                |
| 11                 | 3. 10               |
| 12                 | 3. 18               |
| 13                 | 3. 26               |
| 14                 | 3. 34               |
| 15                 | 3. 42               |
| 16                 | 3. 49               |
| 17                 | 3. 56               |
| 18                 | 4. 3                |
| 19                 | 4. 10               |
| 20                 | 4. 16               |
| 21                 | 4. 22               |
| 22                 | 4. 28               |
| 23                 | 4. 34               |
| 24                 | 4. 40               |
| 26                 | 4. 52               |
| 28                 | 5. 3                |
| 30                 | 5. 14               |
| 35                 | 5. 39               |
| 40                 | 6. 2                |
| 45                 | 6. 24               |
| 50                 | 6. 44               |
| 60                 | 7. 23               |
| 70                 | 7. 59               |
| 80                 | 8. 32               |
| 90                 | 9. 3                |
| 100                | 9. 33               |

TABLE XIV. The Sun's Parallax in Altitude.

| Sun's Alt. | Sun's Parallax. |
|------------|-----------------|
| D.         | S               |
| 0          | 9               |
| 10         | 9               |
| 20         | 8               |
| 30         | 8               |
| 40         | 7               |
| 50         | 6               |
| 55         | 5               |
| 60         | 4               |
| 65         | 4               |
| 70         | 3               |
| 75         | 2               |
| 80         | 2               |
| 85         | 1               |
| 90         | 0               |

TABLE XV. Augmentation of the Moon's Semidiameter.

| Moon's Alt. | Augmen- tation. |
|-------------|-----------------|
| D.          | S.              |
| 0           | 0               |
| 5           | 1               |
| 10          | 3               |
| 15          | 4               |
| 20          | 6               |
| 25          | 7               |
| 30          | 8               |
| 35          | 9               |
| 40          | 10              |
| 45          | 11              |
| 50          | 12              |
| 55          | 13              |
| 60          | 14              |
| 70          | 15              |
| 80&c        | 16              |

TABLE XVI. Dip of the Sea at different Distances from the Observer.

| Dip of the land in sea miles. | Height of the Eye above the Sea in Feet. |      |      |      |      |      |      |      |
|-------------------------------|------------------------------------------|------|------|------|------|------|------|------|
|                               | 5                                        | 10   | 15   | 20   | 25   | 30   | 35   | 40   |
| Dip.                          | Dip.                                     | Dip. | Dip. | Dip. | Dip. | Dip. | Dip. | Dip. |
| M.                            | M.                                       | M.   | M.   | M.   | M.   | M.   | M.   | M.   |
| 11                            | 22                                       | 34   | 45   | 56   | 68   | 79   | 90   |      |
| 6                             | 11                                       | 17   | 22   | 28   | 34   | 39   | 45   |      |
| 4                             | 8                                        | 12   | 15   | 19   | 23   | 27   | 30   |      |
| 1                             | 4                                        | 6    | 9    | 12   | 15   | 17   | 20   | 23   |
| 1 1/2                         | 3                                        | 5    | 7    | 9    | 12   | 14   | 16   | 19   |
| 1 1/4                         | 3                                        | 4    | 6    | 8    | 10   | 12   | 14   | 15   |
| 2                             | 2                                        | 3    | 5    | 6    | 8    | 10   | 11   | 12   |
| 2 1/2                         | 2                                        | 3    | 5    | 6    | 7    | 8    | 9    | 10   |
| 3                             | 2                                        | 3    | 4    | 5    | 6    | 7    | 8    | 8    |
| 3 1/2                         | 2                                        | 3    | 4    | 5    | 6    | 6    | 7    | 7    |
| 4                             | 2                                        | 3    | 4    | 4    | 5    | 6    | 7    | 7    |
| 5                             | 2                                        | 3    | 4    | 4    | 5    | 5    | 6    | 6    |
| 6                             | 2                                        | 3    | 4    | 4    | 5    | 5    | 6    | 6    |

Days.

| Days. |    |
|-------|----|
| 1     | 23 |
| 2     | 22 |
| 3     | 22 |
| 4     | 22 |
| 5     | 22 |
| 6     | 22 |
| 7     | 22 |
| 8     | 22 |
| 9     | 22 |
| 10    | 21 |
| 11    | 21 |
| 12    | 21 |
| 13    | 21 |
| 14    | 21 |
| 15    | 22 |
| 16    | 20 |
| 17    | 20 |
| 18    | 20 |
| 19    | 20 |
| 20    | 20 |
| 21    | 19 |
| 22    | 19 |
| 23    | 19 |
| 24    | 19 |
| 25    | 18 |
| 26    | 18 |
| 27    | 18 |
| 28    | 18 |
| 29    | 17 |
| 30    | 17 |
| 31    | 17 |

TABLE XVII.

## A T A B L E

OF THE

## SUN'S DECLINATION,

For the YEARS 1791, 1795, 1799, 1803.

Each being the third after Leap-Year.

| Days. | Jan.   | Feb.   | March   | April  | May    | June   | July   | Aug.   | Sept.  | Oct.   | Nov.   | Dec.   |
|-------|--------|--------|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|       | South  | South  | South   | North  | North  | North  | North  | North  | North  | South  | South  | South  |
| 1     | 23. 0  | 17. 1  | 7. 28   | 4. 39  | 15. 9  | 22. 6  | 23. 7  | 18. 0  | 8. 14  | 3. 16  | 14. 32 | 21. 52 |
| 2     | 22. 54 | 16. 43 | 7. 5    | 5. 2   | 15. 27 | 22. 16 | 23. 3  | 17. 45 | 7. 52  | 3. 40  | 14. 51 | 22. 1  |
| 3     | 22. 49 | 16. 26 | 6. 42   | 5. 25  | 15. 45 | 22. 21 | 22. 58 | 17. 29 | 7. 30  | 4. 3   | 15. 10 | 22. 10 |
| 4     | 22. 42 | 16. 08 | 6. 19   | 5. 48  | 16. 2  | 22. 28 | 22. 53 | 17. 13 | 7. 8   | 4. 26  | 15. 28 | 22. 18 |
| 5     | 22. 36 | 15. 50 | 5. 56   | 6. 11  | 16. 19 | 22. 35 | 22. 48 | 16. 57 | 6. 45  | 4. 49  | 15. 47 | 22. 26 |
| 6     | 22. 28 | 15. 31 | 5. 33   | 6. 33  | 16. 36 | 22. 41 | 22. 42 | 16. 41 | 6. 23  | 5. 12  | 16. 5  | 22. 33 |
| 7     | 22. 21 | 15. 13 | 5. 10   | 6. 56  | 16. 53 | 22. 47 | 22. 36 | 16. 24 | 6.     | 5. 36  | 16. 23 | 22. 40 |
| 8     | 22. 13 | 14. 54 | 4. 46   | 7. 18  | 17. 9  | 22. 53 | 22. 29 | 16. 7  | 5. 38  | 5. 59  | 16. 40 | 22. 46 |
| 9     | 22. 4  | 14. 34 | 4. 23   | 7. 40  | 17. 25 | 22. 58 | 22. 22 | 15. 50 | 5. 15  | 6. 21  | 16. 57 | 22. 52 |
| 10    | 21. 55 | 14. 15 | 3. 59   | 8. 3   | 17. 41 | 23. 3  | 22. 15 | 15. 32 | 4. 52  | 6. 44  | 17. 14 | 22. 58 |
| 11    | 21. 46 | 13. 55 | 3. 36   | 8. 25  | 17. 57 | 23. 7  | 22. 7  | 15. 14 | 4. 30  | 7. 7   | 17. 31 | 23. 3  |
| 12    | 21. 36 | 13. 35 | 3. 12   | 8. 47  | 18. 12 | 23. 11 | 21. 58 | 14. 56 | 4. 7   | 7. 30  | 17. 47 | 23. 8  |
| 13    | 21. 26 | 13. 15 | 2. 49   | 9. 8   | 18. 27 | 23. 15 | 21. 50 | 14. 38 | 3. 44  | 7. 52  | 18. 4  | 23. 12 |
| 14    | 21. 16 | 12. 55 | 2. 25   | 9. 30  | 18. 41 | 23. 18 | 21. 41 | 14. 20 | 3. 21  | 8. 15  | 18. 19 | 23. 15 |
| 15    | 22. 5  | 12. 34 | 2. 1    | 9. 51  | 18. 56 | 23. 20 | 21. 32 | 14. 1  | 2. 57  | 8. 37  | 18. 35 | 23. 19 |
| 16    | 20. 53 | 12. 13 | 1. 38   | 10. 13 | 19. 10 | 23. 23 | 21. 22 | 13. 42 | 2. 34  | 8. 59  | 18. 50 | 23. 21 |
| 17    | 20. 41 | 11. 52 | 1. 14   | 10. 34 | 19. 23 | 23. 24 | 21. 12 | 13. 23 | 2. 11  | 9. 21  | 19. 5  | 23. 24 |
| 18    | 20. 29 | 11. 31 | 0. 50   | 10. 55 | 19. 36 | 23. 26 | 21. 1  | 13. 4  | 1. 48  | 9. 43  | 19. 19 | 23. 25 |
| 19    | 20. 17 | 11. 10 | 0. 27   | 11. 16 | 19. 49 | 23. 27 | 20. 51 | 12. 44 | 1. 24  | 10. 05 | 19. 33 | 23. 27 |
| 20    | 20. 4  | 10. 48 | 0. 03   | 11. 36 | 20. 2  | 23. 28 | 20. 39 | 12. 24 | 1. 1   | 10. 26 | 19. 47 | 23. 27 |
| 21    | 19. 50 | 10. 27 | 0. 21 N | 11. 57 | 20. 14 | 23. 28 | 20. 28 | 12. 4  | 0. 38  | 10. 48 | 20.    | 23. 28 |
| 22    | 19. 37 | 10. 05 | 0. 45   | 12. 17 | 20. 26 | 23. 28 | 20. 16 | 11. 44 | 0. 14  | 11. 09 | 20. 13 | 23. 28 |
| 23    | 19. 23 | 9. 43  | 1. 8    | 12. 37 | 20. 38 | 23. 27 | 20. 4  | 11. 24 | 0. 98. | 11. 30 | 20. 26 | 23. 27 |
| 24    | 19. 8  | 9. 21  | 1. 32   | 12. 57 | 20. 49 | 23. 26 | 19. 51 | 11. 3  | 0. 33  | 11. 51 | 20. 38 | 23. 26 |
| 25    | 18. 53 | 8. 58  | 1. 55   | 13. 16 | 21.    | 23. 25 | 19. 39 | 10. 43 | 0. 56  | 12. 12 | 20. 50 | 23. 25 |
| 26    | 18. 38 | 8. 36  | 2. 19   | 13. 36 | 21. 10 | 23. 23 | 19. 25 | 10. 22 | 1. 20  | 12. 33 | 21. 1  | 23. 23 |
| 27    | 18. 23 | 8. 14  | 2. 42   | 13. 55 | 21. 21 | 23. 21 | 19. 12 | 10. 1  | 1. 43  | 12. 53 | 21. 12 | 23. 20 |
| 28    | 18. 07 | 7. 51  | 3. 6    | 14. 14 | 21. 30 | 23. 18 | 18. 58 | 9. 40  | 2. 6   | 13. 13 | 21. 2  | 23. 17 |
| 29    | 17. 51 |        | 3. 29   | 14. 33 | 21. 40 | 23. 15 | 18. 44 | 9. 18  | 2. 30  | 13. 33 | 21. 33 | 23. 14 |
| 30    | 17. 34 |        | 3. 52   | 14. 51 | 21. 49 | 23. 11 | 18. 30 | 8. 57  | 2. 53  | 13. 53 | 21. 43 | 23. 10 |
| 31    | 17. 18 |        | 4. 16   |        | 21. 58 |        | 18. 15 | 8. 35  |        | 14. 12 |        | 23. 6  |



TABLE XVII.

## A T A B L E

OF THE

## SUN'S DECLINATION,

For the YEARS 1792, 1796, 1800, 1804.

Each Being Leap-Year.

| Days. | Jan.  | Feb.  | March | April | May   | June  | July  | Aug.  | Sept. | Oct.  | Nov.  | Dec.  |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|       | South | South | South | North | North | North | North | North | North | South | South | South |
| 1     | 23. 1 | 17. 5 | 7.11  | 4.56  | 15.23 | 22.12 | 23. 4 | 17.48 | 7.57  | 3.34  | 14.46 | 21.59 |
| 2     | 22.56 | 16.48 | 6.48  | 5.19  | 15.40 | 22.19 | 23. 5 | 17.33 | 7.35  | 3.57  | 15. 5 | 22. 8 |
| 3     | 22.50 | 16.30 | 6.25  | 5.42  | 15.58 | 22.27 | 22.55 | 17.17 | 7.13  | 4.21  | 15.24 | 22.16 |
| 4     | 22.44 | 16.12 | 6. 2  | 6.05  | 16.15 | 22.34 | 22.49 | 17. 1 | 6.51  | 4.44  | 15.42 | 22.24 |
| 5     | 22.37 | 15.54 | 5.39  | 6.28  | 16.32 | 22.40 | 22.43 | 16.45 | 6.28  | 5. 7  | 16. 1 | 22.32 |
| 6     | 22.30 | 15.36 | 5.15  | 6.50  | 16.49 | 22.46 | 22.37 | 16.28 | 6. 6  | 5.30  | 16.18 | 22.39 |
| 7     | 22.23 | 15.17 | 4.52  | 7.13  | 17.05 | 22.52 | 22.31 | 16.11 | 5.43  | 5.53  | 16.36 | 22.45 |
| 8     | 22.15 | 14.58 | 4.29  | 7.35  | 17.22 | 22.57 | 22.24 | 15.54 | 5.21  | 6.16  | 16.53 | 22.51 |
| 9     | 22. 6 | 14.39 | 4. 5  | 7.57  | 17.37 | 23. 2 | 22.16 | 15.36 | 4.58  | 6.39  | 17.10 | 22.57 |
| 10    | 21.58 | 14.20 | 3.42  | 8.19  | 17.53 | 23. 6 | 22. 9 | 15.19 | 4.35  | 7. 2  | 17.27 | 23. 2 |
| 11    | 21.48 | 14. 0 | 3.18  | 8.41  | 18. 8 | 23.10 | 22. 0 | 15. 1 | 4.12  | 7.24  | 17.44 | 23. 7 |
| 12    | 21.39 | 13.40 | 2.54  | 9.03  | 18.23 | 23.14 | 21.52 | 14.43 | 3.49  | 7.47  | 18. 5 | 23.11 |
| 13    | 21.29 | 13.20 | 2.31  | 9.25  | 18.38 | 23.17 | 21.43 | 14.24 | 3.26  | 8. 9  | 18.15 | 23.15 |
| 14    | 21.18 | 13. 0 | 2.07  | 9.46  | 18.52 | 23.20 | 21.34 | 14. 6 | 3. 3  | 8.31  | 18.31 | 23.18 |
| 15    | 21. 7 | 12.39 | 1.43  | 10.08 | 19. 6 | 23.22 | 21.24 | 13.47 | 2.40  | 8.54  | 18.46 | 23.21 |
| 16    | 20.56 | 12.18 | 1.20  | 10.29 | 19.20 | 23.24 | 21.14 | 13.28 | 2.17  | 9.16  | 19. 1 | 23.23 |
| 17    | 20.44 | 11.58 | 0.56  | 10.50 | 19.33 | 23.26 | 21. 4 | 13. 8 | 1.53  | 9.38  | 19.16 | 23.25 |
| 18    | 20.32 | 11.36 | 0.32  | 11.11 | 19.46 | 23.27 | 20.53 | 12.49 | 1.30  | 9.59  | 19.30 | 23.26 |
| 19    | 20.20 | 11.15 | 0. 9  | 11.31 | 19.59 | 23.28 | 20.42 | 12.29 | 1. 7  | 10.21 | 19.43 | 23.27 |
| 20    | 20. 7 | 10.54 | 0.15N | 11.52 | 20.11 | 23.28 | 20.31 | 12. 9 | 0.43  | 10.43 | 19.57 | 23.28 |
| 21    | 19.54 | 10.32 | 0.39  | 12.12 | 20.23 | 23.28 | 20.19 | 11.49 | 0.20  | 11. 4 | 20.10 | 23.28 |
| 22    | 19.40 | 10.10 | 1. 2  | 12.32 | 20.35 | 23.27 | 20. 7 | 11.29 | 0.3S  | 11.25 | 20.23 | 23.27 |
| 23    | 19.26 | 9.48  | 1.26  | 12.52 | 20.46 | 23.26 | 19.55 | 11. 9 | 0.27  | 11.46 | 20.35 | 23.27 |
| 24    | 19.12 | 9.26  | 1.49  | 13.12 | 20.57 | 23.25 | 19.42 | 10.48 | 0.50  | 12. 7 | 20.47 | 23.25 |
| 25    | 18.57 | 9. 4  | 2.13  | 13.31 | 21.08 | 23.23 | 19.29 | 10.27 | 1.14  | 12.28 | 20.59 | 23.24 |
| 26    | 18.42 | 8.42  | 2.37  | 13.50 | 21.18 | 23.21 | 19.15 | 10. 6 | 1.37  | 12.48 | 21.10 | 23.21 |
| 27    | 18.27 | 8.19  | 3. 0  | 14. 9 | 21.28 | 23.18 | 19. 2 | 9.45  | 2. 1  | 13. 8 | 21.20 | 23.18 |
| 28    | 18.11 | 7.57  | 3.23  | 14.28 | 21.38 | 23.16 | 18.48 | 9.24  | 2.24  | 13.28 | 21.31 | 23.15 |
| 29    | 17.55 | 7.34  | 3.47  | 14.46 | 21.47 | 23.12 | 18.33 | 9. 2  | 3.47  | 13.48 | 21.41 | 23.11 |
| 30    | 17.39 |       | 4.10  | 15.05 | 21.55 | 23.08 | 18.19 | 8.41  | 3.11  | 14. 8 | 21.50 | 23. 7 |
| 31    | 17.22 |       | 4.33  |       | 22. 4 |       | 18. 4 | 8.19  |       | 14.27 |       | 23. 2 |

TABLE XVII.

## A T A B L E

OF THE

## SUN'S DECLINATION,

For the YEARS 1793, 1797, 1801, 1805.

Being the first after Leap-Year.

| Days. | Jan.   | Feb.   | March | April  | May    | June   | July   | Aug.   | Sept.  | Oct.   | Nov.   | Dec.   |
|-------|--------|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|       | South  | South  | South | North  | North  | North  | North  | North  | North  | South  | South  | South  |
| 1     | 22. 57 | 16. 52 | 7. 17 | 4. 50  | 15. 18 | 22. 10 | 23. 5  | 17. 53 | 8. 3   | 3. 28  | 14. 41 | 21. 57 |
| 2     | 22. 52 | 16. 35 | 6. 54 | 5. 13  | 15. 36 | 22. 17 | 23. 1  | 17. 37 | 7. 41  | 3. 51  | 15. 1  | 22. 6  |
| 3     | 22. 45 | 16. 17 | 6. 31 | 5. 36  | 15. 53 | 22. 25 | 22. 56 | 17. 21 | 7. 19  | 4. 14  | 15. 19 | 22. 14 |
| 4     | 22. 39 | 15. 59 | 6. 8  | 5. 59  | 16. 11 | 22. 32 | 22. 50 | 17. 5  | 6. 57  | 4. 37  | 15. 37 | 22. 22 |
| 5     | 22. 32 | 15. 41 | 5. 45 | 6. 21  | 16. 28 | 22. 38 | 22. 45 | 16. 49 | 6. 34  | 5. 1   | 15. 56 | 22. 30 |
| 6     | 22. 25 | 15. 22 | 5. 22 | 6. 44  | 16. 44 | 22. 44 | 22. 38 | 16. 33 | 6. 12  | 5. 24  | 16. 14 | 22. 37 |
| 7     | 22. 17 | 15. 3  | 4. 58 | 7. 7   | 17. 1  | 22. 50 | 22. 32 | 16. 16 | 5. 49  | 5. 47  | 16. 31 | 22. 43 |
| 8     | 22. 9  | 14. 44 | 4. 35 | 7. 29  | 17. 17 | 22. 55 | 22. 26 | 15. 59 | 5. 27  | 6. 10  | 16. 49 | 22. 49 |
| 9     | 22. 1  | 14. 24 | 4. 11 | 7. 51  | 17. 33 | 23. 1  | 22. 18 | 15. 41 | 5. 4   | 6. 33  | 17. 6  | 22. 55 |
| 10    | 21. 51 | 14. 5  | 3. 48 | 8. 13  | 17. 49 | 23. 5  | 22. 11 | 15. 24 | 4. 41  | 6. 55  | 17. 23 | 23. 1  |
| 11    | 21. 41 | 13. 45 | 3. 24 | 8. 35  | 18. 4  | 23. 9  | 22. 3  | 15. 6  | 4. 18  | 7. 18  | 17. 39 | 23. 5  |
| 12    | 21. 31 | 13. 25 | 3. 1  | 8. 57  | 18. 19 | 23. 13 | 21. 54 | 14. 48 | 3. 55  | 7. 41  | 17. 56 | 23. 10 |
| 13    | 21. 21 | 13. 5  | 2. 37 | 9. 19  | 18. 34 | 23. 16 | 21. 45 | 14. 29 | 3. 32  | 8. 3   | 18. 11 | 23. 14 |
| 14    | 21. 10 | 12. 45 | 2. 13 | 9. 40  | 18. 48 | 23. 19 | 21. 30 | 14. 11 | 3. 9   | 8. 25  | 18. 27 | 23. 17 |
| 15    | 20. 59 | 12. 24 | 1. 50 | 10. 2  | 19. 2  | 23. 21 | 21. 27 | 13. 52 | 2. 46  | 8. 48  | 18. 42 | 23. 20 |
| 16    | 20. 47 | 12. 3  | 1. 26 | 10. 23 | 19. 16 | 23. 23 | 21. 17 | 13. 33 | 2. 23  | 9. 10  | 18. 57 | 23. 22 |
| 17    | 20. 35 | 11. 42 | 1. 2  | 10. 44 | 19. 30 | 23. 25 | 21. 7  | 13. 14 | 2. 1   | 9. 32  | 19. 12 | 23. 24 |
| 18    | 20. 23 | 11. 21 | 0. 39 | 11. 5  | 19. 42 | 23. 27 | 20. 56 | 12. 54 | 1. 36  | 9. 54  | 19. 26 | 23. 26 |
| 19    | 20. 10 | 10. 59 | 0. 15 | 11. 26 | 19. 56 | 23. 27 | 20. 45 | 12. 34 | 1. 13  | 10. 15 | 19. 40 | 23. 27 |
| 20    | 19. 57 | 10. 38 | 0. 9N | 11. 46 | 20. 8  | 23. 28 | 20. 34 | 12. 15 | 0. 50  | 10. 37 | 19. 53 | 23. 28 |
| 21    | 19. 44 | 10. 16 | 0. 32 | 12. 6  | 20. 20 | 23. 28 | 20. 22 | 11. 55 | 0. 26  | 10. 58 | 20. 6  | 23. 28 |
| 22    | 19. 30 | 9. 54  | 0. 56 | 12. 27 | 20. 32 | 23. 27 | 20. 10 | 11. 34 | 0. 3 S | 11. 19 | 20. 19 | 23. 27 |
| 23    | 19. 15 | 9. 32  | 1. 20 | 12. 47 | 20. 43 | 23. 27 | 19. 58 | 11. 14 | 0. 21  | 11. 40 | 20. 32 | 23. 27 |
| 24    | 19. 1  | 9. 10  | 1. 43 | 13. 6  | 20. 54 | 23. 25 | 19. 45 | 10. 54 | 0. 44  | 12. 1  | 20. 44 | 23. 26 |
| 25    | 18. 46 | 8. 48  | 2. 7  | 13. 26 | 21. 5  | 23. 24 | 19. 32 | 10. 33 | 1. 7   | 12. 22 | 20. 55 | 23. 24 |
| 26    | 18. 31 | 8. 25  | 2. 30 | 13. 45 | 21. 15 | 23. 22 | 19. 19 | 10. 12 | 1. 31  | 12. 43 | 21. 7  | 23. 22 |
| 27    | 18. 14 | 8. 3   | 2. 54 | 14. 5  | 21. 25 | 23. 19 | 19. 5  | 9. 51  | 1. 54  | 13. 3  | 21. 18 | 23. 19 |
| 28    | 17. 59 | 7. 40  | 3. 17 | 14. 23 | 21. 35 | 23. 16 | 18. 51 | 9. 29  | 2. 18  | 13. 23 | 21. 28 | 23. 16 |
| 29    | 17. 43 |        | 3. 40 | 14. 41 | 21. 44 | 23. 13 | 18. 37 | 9. 8   | 2. 41  | 13. 43 | 21. 38 | 23. 12 |
| 30    | 17. 26 |        | 4. 4  | 15. 1  | 21. 53 | 23. 9  | 18. 23 | 8. 47  | 3. 4   | 14. 2  | 21. 48 | 23. 8  |
| 31    | 17. 10 |        | 4. 27 |        | 22. 2  |        | 18. 8  | 8. 25  |        |        |        | 23. 4  |

Y y

TABLE XVII.

# A T A B L E

## OF THE

### S U N ' s   D E C L I N A T I O N

For the YEARS 1794, 1798, 1802, 1806.

Each being the second after Leap-Year.

| Days. | Jan.   | Feb.   | March | April  | May    | June   | July   | Aug.   | Sept.   | Oct.   | Nov.   | Dec.   |
|-------|--------|--------|-------|--------|--------|--------|--------|--------|---------|--------|--------|--------|
|       | South  | South  | South | North  | North  | North  | North  | North  | North   | South  | South  | South  |
| 1     | 22. 58 | 16. 57 | 7. 23 | 4. 44  | 15. 14 | 22. 8  | 23. 6  | 17. 56 | 8. 8    | 3. 22  | 14. 37 | 21. 55 |
| 2     | 22. 53 | 16. 39 | 7.    | 5. 7   | 15. 31 | 22. 16 | 23. 2  | 17. 41 | 7. 46   | 3. 45  | 14. 56 | 21. 4  |
| 3     | 22. 47 | 16. 21 | 6. 37 | 5. 30  | 15. 49 | 22. 23 | 22. 57 | 17. 25 | 7. 24   | 4. 9   | 15. 14 | 22. 12 |
| 4     | 22. 41 | 16. 3  | 6. 14 | 5. 53  | 16. 06 | 22. 30 | 22. 52 | 17. 9  | 7. 2    | 4. 32  | 15. 33 | 22. 20 |
| 5     | 22. 34 | 15. 45 | 5. 51 | 6. 16  | 16. 24 | 22. 37 | 22. 46 | 16. 53 | 6. 40   | 4. 55  | 15. 51 | 22. 28 |
| 6     | 22. 27 | 15. 27 | 5. 27 | 6. 39  | 16. 40 | 22. 43 | 22. 41 | 16. 37 | 6. 17   | 5. 18  | 16. 9  | 22. 35 |
| 7     | 22. 19 | 15. 8  | 5. 4  | 7. 1   | 16. 57 | 22. 49 | 22. 34 | 16. 20 | 5. 55   | 5. 41  | 16. 27 | 22. 42 |
| 8     | 22. 11 | 14. 49 | 4. 40 | 7. 24  | 17. 13 | 22. 54 | 22. 27 | 16. 3  | 5. 32   | 6. 4   | 16. 44 | 22. 47 |
| 9     | 22. 2  | 14. 30 | 4. 17 | 7. 46  | 17. 29 | 22. 59 | 22. 20 | 15. 46 | 5. 10   | 6. 27  | 17. 2  | 22. 54 |
| 10    | 21. 53 | 14. 10 | 3. 54 | 8. 8   | 17. 45 | 23. 4  | 22. 13 | 15. 28 | 4. 47   | 6. 50  | 17. 19 | 22. 59 |
| 11    | 21. 44 | 13. 50 | 3. 30 | 8. 30  | 18. 1  | 23. 8  | 22. 5  | 15. 10 | 4. 24   | 7. 13  | 17. 35 | 23. 4  |
| 12    | 21. 34 | 13. 30 | 3. 6  | 8. 52  | 18. 16 | 23. 12 | 21. 57 | 14. 52 | 4. 1    | 7. 35  | 17. 51 | 23. 8  |
| 13    | 21. 24 | 13. 10 | 2. 43 | 9. 14  | 18. 30 | 23. 15 | 21. 48 | 14. 34 | 3. 38   | 7. 58  | 18. 7  | 23. 13 |
| 14    | 21. 13 | 12. 50 | 2. 19 | 9. 35  | 18. 45 | 23. 18 | 21. 39 | 14. 15 | 3. 15   | 8. 20  | 18. 23 | 23. 16 |
| 15    | 21. 2  | 12. 29 | 1. 56 | 9. 57  | 18. 59 | 23. 21 | 21. 30 | 13. 57 | 2. 52   | 8. 41  | 18. 38 | 23. 19 |
| 16    | 20. 50 | 12. 8  | 1. 32 | 10. 17 | 19. 13 | 23. 23 | 21. 20 | 13. 38 | 2. 29   | 9. 4   | 18. 53 | 23. 22 |
| 17    | 20. 38 | 11. 47 | 1. 8  | 10. 39 | 19. 26 | 23. 25 | 21. 9  | 13. 19 | 2. 6    | 9. 26  | 19. 8  | 23. 24 |
| 18    | 20. 26 | 11. 26 | 0. 45 | 11. 0  | 19. 40 | 23. 26 | 20. 59 | 12. 59 | 1. 42   | 9. 48  | 19. 22 | 23. 26 |
| 19    | 20. 13 | 11. 5  | 0. 21 | 11. 21 | 19. 52 | 23. 27 | 20. 48 | 12. 40 | 1. 19   | 10. 10 | 19. 36 | 23. 27 |
| 20    | 20. 1  | 10. 43 | 0. 3N | 11. 41 | 20. 05 | 23. 28 | 20. 37 | 12. 20 | 0. 56   | 10. 32 | 19. 50 | 23. 28 |
| 21    | 19. 47 | 10. 22 | 0. 27 | 12. 2  | 20. 17 | 23. 28 | 20. 25 | 12.    | 0. 32   | 10. 53 | 20. 3  | 23. 28 |
| 22    | 19. 33 | 10.    | 0. 50 | 12. 22 | 20. 29 | 23. 28 | 20. 13 | 11. 40 | 0. 9    | 11. 14 | 20. 16 | 23. 28 |
| 23    | 19. 19 | 9. 38  | 1. 14 | 12. 42 | 20. 41 | 23. 27 | 20. 1  | 11. 19 | 0. 15 S | 11. 35 | 20. 29 | 23. 27 |
| 24    | 19. 5  | 9. 16  | 1. 37 | 13. 1  | 20. 52 | 23. 26 | 19. 48 | 10. 59 | 0. 38   | 11. 56 | 20. 41 | 23. 25 |
| 25    | 18. 50 | 8. 53  | 2. 1  | 13. 21 | 21. 3  | 23. 24 | 19. 36 | 10. 38 | 1. 2    | 12. 17 | 20. 53 | 23. 24 |
| 26    | 18. 35 | 8. 31  | 2. 25 | 13. 40 | 21. 13 | 23. 22 | 19. 22 | 10. 17 | 1. 25   | 12. 38 | 21. 4  | 23. 22 |
| 27    | 18. 19 | 8. 8   | 2. 48 | 13. 59 | 21. 23 | 23. 20 | 19. 9  | 9. 56  | 1. 49   | 12. 58 | 21. 15 | 23. 20 |
| 28    | 18. 3  | 7. 45  | 3. 11 | 14. 18 | 21. 33 | 23. 17 | 18. 55 | 9. 35  | 2. 12   | 13. 18 | 21. 26 | 23. 17 |
| 29    | 17. 47 |        | 3. 35 | 14. 37 | 21. 42 | 23. 16 | 18. 41 | 9. 13  | 2. 36   | 13. 38 | 21. 36 | 23. 13 |
| 30    | 17. 30 |        | 3. 58 | 14. 55 | 21. 51 | 23. 10 | 18. 26 | 8. 52  | 2. 59   | 13. 58 | 21. 45 | 23. 9  |
| 31    | 17. 14 |        | 4. 21 |        | 22.    |        | 18. 12 | 8. 30  |         | 14. 17 |        | 23. 5  |



TABLE XVIII. For reducing the SUN'S DECLIN. as given in the N. A. for Noon at GREENWICH to any other Time under that Merid. or to Noon under any other Merid.

| Add after N.<br>Sub. bef. N. | Sub. aft. N.<br>Add bef. N. | H. M. | H. M. | H. M. | H. M. | H. M. | H. M. | H. M. | H. M. | Sub. aft. N.<br>Add bef. N. | Add aft. N.<br>Sub. bef. N. |
|------------------------------|-----------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-----------------------------|-----------------------------|
| Add in W.<br>Sub. in E.      | Sub. in W.<br>Add in E.     | 5Deg. | 10D   | 15D   | 20D   | 25D   | 30D   | 35D   | 40D   | Sub. in W.<br>Add in E.     | Add in W.<br>Sub. in E.     |
| Days.                        | Days.                       | M. S. | M. S. | M. S. | M. S. | M. S. | M. S. | M. S. | M. S. | Days.                       | Days.                       |
| December 21                  | Decem. 21                   | 0. 0  | 0. 0  | 0. 0  | 0. 0  | 0. 0  | 0. 0  | 0. 0  | 0. 0  | 21 June                     | 21 June                     |
| 20                           | 22                          | 0. 0  | 0. 1  | 0. 1  | 0. 1  | 0. 2  | 0. 2  | 0. 2  | 0. 3  | 22                          | 20                          |
| 19                           | 23                          | 0. 0  | 0. 1  | 0. 2  | 0. 2  | 0. 3  | 0. 4  | 0. 5  | 0. 6  | 23                          | 19                          |
| 18                           | 24                          | 0. 1  | 0. 2  | 0. 3  | 0. 4  | 0. 6  | 0. 7  | 0. 8  | 0. 9  | 24                          | 18                          |
| 17                           | 25                          | 0. 1  | 0. 3  | 0. 4  | 0. 6  | 0. 7  | 0. 9  | 0. 11 | 0. 12 | 25                          | 17                          |
| 16                           | 26                          | 0. 2  | 0. 4  | 0. 5  | 0. 7  | 0. 9  | 0. 11 | 0. 13 | 0. 15 | 26                          | 16                          |
| 15                           | 27                          | 0. 2  | 0. 5  | 0. 6  | 0. 8  | 0. 11 | 0. 13 | 0. 15 | 0. 18 | 27                          | 15                          |
| 14                           | 28                          | 0. 3  | 0. 6  | 0. 7  | 0. 10 | 0. 12 | 0. 15 | 0. 18 | 0. 21 | 28                          | 14                          |
| 13                           | 29                          | 0. 3  | 0. 7  | 0. 9  | 0. 12 | 0. 15 | 0. 18 | 0. 21 | 0. 24 | 29                          | 13                          |
| 12                           | 30                          | 0. 3  | 0. 7  | 0. 10 | 0. 13 | 0. 17 | 0. 20 | 0. 23 | 0. 27 | 30 June                     | 12                          |
| 11                           | Decem. 31                   | 0. 4  | 0. 8  | 0. 11 | 0. 15 | 0. 19 | 0. 22 | 0. 26 | 0. 30 | 1 July                      | 11                          |
| 10                           | Jan. 1                      | 0. 4  | 0. 8  | 0. 12 | 0. 16 | 0. 20 | 0. 24 | 0. 28 | 0. 32 | 2                           | 10                          |
| 9                            | 2                           | 0. 4  | 0. 8  | 0. 13 | 0. 17 | 0. 21 | 0. 26 | 0. 30 | 0. 35 | 3                           | 9                           |
| 8                            | 3                           | 0. 5  | 0. 9  | 0. 14 | 0. 19 | 0. 24 | 0. 29 | 0. 33 | 0. 38 | 4                           | 8                           |
| 7                            | 4                           | 0. 5  | 0. 10 | 0. 15 | 0. 21 | 0. 26 | 0. 31 | 0. 36 | 0. 41 | 5                           | 7                           |
| 6                            | 5                           | 0. 5  | 0. 11 | 0. 16 | 0. 22 | 0. 28 | 0. 33 | 0. 38 | 0. 44 | 6                           | 6                           |
| 5                            | 6                           | 0. 6  | 0. 12 | 0. 17 | 0. 24 | 0. 30 | 0. 35 | 0. 41 | 0. 47 | 7                           | 5                           |
| 4                            | 7                           | 0. 6  | 0. 12 | 0. 18 | 0. 25 | 0. 31 | 0. 37 | 0. 43 | 0. 49 | 8                           | 4                           |
| 3                            | 8                           | 0. 6  | 0. 13 | 0. 19 | 0. 26 | 0. 33 | 0. 39 | 0. 45 | 0. 52 | 9                           | 3                           |
| 2                            | 9                           | 0. 7  | 0. 14 | 0. 20 | 0. 27 | 0. 34 | 0. 41 | 0. 48 | 0. 55 | 10                          | 2                           |
| December 1                   | 10                          | 0. 7  | 0. 14 | 0. 21 | 0. 29 | 0. 36 | 0. 43 | 0. 50 | 0. 57 | 11                          | 1 June                      |
| November 30                  | 11                          | 0. 7  | 0. 15 | 0. 22 | 0. 30 | 0. 37 | 0. 45 | 0. 52 | 1. 0  | 12                          | 31 May                      |
| 29                           | 12                          | 0. 8  | 0. 16 | 0. 23 | 0. 31 | 0. 39 | 0. 47 | 0. 55 | 1. 3  | 13                          | 30                          |
| 28                           | 13                          | 0. 8  | 0. 16 | 0. 24 | 0. 33 | 0. 41 | 0. 49 | 0. 57 | 1. 6  | 14                          | 29                          |
| 27                           | 14                          | 0. 8  | 0. 17 | 0. 25 | 0. 34 | 0. 42 | 0. 51 | 0. 59 | 1. 8  | 15                          | 28                          |
| 26                           | 15                          | 0. 9  | 0. 18 | 0. 26 | 0. 35 | 0. 44 | 0. 53 | 1. 2  | 1. 11 | 16                          | 27                          |
| 25                           | 16                          | 0. 9  | 0. 18 | 0. 27 | 0. 37 | 0. 46 | 0. 55 | 1. 4  | 1. 13 | 17                          | 26                          |
| 24                           | 17                          | 0. 9  | 0. 19 | 0. 28 | 0. 38 | 0. 47 | 0. 57 | 1. 6  | 1. 16 | 18                          | 25                          |
| 23                           | 18                          | 0. 10 | 0. 20 | 0. 29 | 0. 39 | 0. 49 | 0. 58 | 1. 9  | 1. 19 | 19                          | 24                          |
| 22                           | 19                          | 0. 10 | 0. 20 | 0. 30 | 0. 40 | 0. 50 | 1. 0  | 1. 10 | 1. 20 | 20                          | 23                          |
| 21                           | 20                          | 0. 10 | 0. 21 | 0. 31 | 0. 41 | 0. 51 | 1. 2  | 1. 12 | 1. 22 | 21                          | 22                          |
| 20                           | 21                          | 0. 11 | 0. 22 | 0. 32 | 0. 43 | 0. 53 | 1. 4  | 1. 14 | 1. 25 | 22                          | 21                          |
| 19                           | 22                          | 0. 11 | 0. 22 | 0. 33 | 0. 44 | 0. 55 | 1. 6  | 1. 17 | 1. 28 | 23                          | 20                          |
| 18                           | 23                          | 0. 11 | 0. 23 | 0. 34 | 0. 45 | 0. 56 | 1. 7  | 1. 19 | 1. 30 | 24                          | 19                          |
| 17                           | 24                          | 0. 12 | 0. 23 | 0. 34 | 0. 46 | 0. 57 | 1. 9  | 1. 21 | 1. 32 | 25                          | 18                          |
| 16                           | 25                          | 0. 12 | 0. 24 | 0. 35 | 0. 47 | 0. 59 | 1. 11 | 1. 23 | 1. 35 | 26                          | 17                          |
| 15                           | 26                          | 0. 12 | 0. 24 | 0. 36 | 0. 48 | 1. 0  | 1. 12 | 1. 24 | 1. 36 | 27                          | 16                          |
| 14                           | 27                          | 0. 12 | 0. 25 | 0. 37 | 0. 49 | 1. 2  | 1. 14 | 1. 26 | 1. 39 | 28                          | 15                          |
| 13                           | 28                          | 0. 13 | 0. 26 | 0. 38 | 0. 51 | 1. 4  | 1. 16 | 1. 28 | 1. 41 | 29                          | 14                          |
| 12                           | 29                          | 0. 13 | 0. 26 | 0. 39 | 0. 53 | 1. 6  | 1. 19 | 1. 32 | 1. 45 | 30 July                     | 12                          |
| 11                           | Jan. 30                     | 0. 13 | 0. 27 | 0. 41 | 0. 55 | 1. 9  | 1. 22 | 1. 36 | 1. 50 | 2 August                    | 10                          |
| 9                            | Feb. 1                      | 0. 14 | 0. 28 | 0. 42 | 0. 57 | 1. 11 | 1. 25 | 1. 39 | 1. 53 | 4                           | 8                           |
| 7                            | 3                           | 0. 14 | 0. 29 | 0. 43 | 0. 58 | 1. 13 | 1. 27 | 1. 42 | 1. 56 | 6                           | 6                           |
| 5                            | 5                           | 0. 15 | 0. 30 | 0. 45 | 1. 0  | 1. 15 | 1. 30 | 1. 44 | 1. 59 | 8                           | 4                           |
| 3                            | 7                           | 0. 15 | 0. 31 | 0. 46 | 1. 2  | 1. 17 | 1. 32 | 1. 47 | 2. 3  | 10                          | 2 May                       |
| November 1                   | 9                           | 0. 16 | 0. 32 | 0. 47 | 1. 3  | 1. 19 | 1. 35 | 1. 50 | 2. 6  | 12                          | 30 April                    |
| October 30                   | 11                          | 0. 16 | 0. 32 | 0. 48 | 1. 5  | 1. 21 | 1. 37 | 1. 53 | 2. 9  | 14                          | 28                          |
| 28                           | 13                          | 0. 16 | 0. 33 | 0. 49 | 1. 6  | 1. 22 | 1. 39 | 1. 56 | 2. 12 | 16                          | 26                          |
| 26                           | 15                          | 0. 17 | 0. 34 | 0. 50 | 1. 7  | 1. 24 | 1. 41 | 1. 58 | 2. 15 | 18                          | 24                          |
| 24                           | 17                          | 0. 17 | 0. 34 | 0. 52 | 1. 9  | 1. 27 | 1. 44 | 2. 1  | 2. 19 | 20                          | 22                          |
| 22                           | 20                          | 0. 17 | 0. 35 | 0. 53 | 1. 11 | 1. 29 | 1. 46 | 2. 4  | 2. 22 | 24                          | 18                          |
| 18                           | 23                          | 0. 18 | 0. 36 | 0. 54 | 1. 13 | 1. 31 | 1. 49 | 2. 7  | 2. 25 | 27                          | 15                          |
| 15                           | Feb. 26                     | 0. 18 | 0. 37 | 0. 55 | 1. 14 | 1. 32 | 1. 51 | 2. 9  | 2. 28 | 30 August                   | 12                          |
| 12                           | March 1                     | 0. 19 | 0. 38 | 0. 56 | 1. 15 | 1. 34 | 1. 53 | 2. 12 | 2. 30 | 2 September                 | 9                           |
| 9                            | 4                           | 0. 19 | 0. 38 | 0. 57 | 1. 16 | 1. 35 | 1. 54 | 2. 13 | 2. 32 | 5                           | 6                           |
| 6                            | 7                           | 0. 19 | 0. 38 | 0. 57 | 1. 17 | 1. 36 | 1. 55 | 2. 14 | 2. 34 | 8                           | 3 April                     |
| October 3                    | 10                          | 0. 19 | 0. 39 | 0. 58 | 1. 17 | 1. 37 | 1. 56 | 2. 15 | 2. 35 | 11                          | 31                          |
| September 30                 | 13                          | 0. 19 | 0. 39 | 0. 58 | 1. 18 | 1. 38 | 1. 57 | 2. 16 | 2. 36 | 14                          |                             |
| 27                           | 16                          | 0. 20 | 0. 39 | 0. 58 | 1. 18 | 1. 38 | 1. 57 | 2. 16 | 2. 36 | 17                          |                             |
| 24                           | 19                          | 0. 20 | 0. 40 | 0. 59 | 1. 19 | 1. 39 | 1. 58 | 2. 17 | 2. 36 | 20                          |                             |
| 21                           | 22                          | 0. 20 | 0. 40 | 0. 59 | 1. 19 | 1. 39 | 1. 58 | 2. 17 | 2. 36 | 20                          |                             |

TAB. XVIII. For reducing the SUN'S DECLIN. as given in the N. A. for Noon at GREENWICH to any other Time under that Merid. or to Noon under any other Merid.

| Add aft. N.  | Sub. aft. N. | H. M. | H. M. | H. M. | H. M. | H. M. | H. M. | H. M. | Sub. aft. N. | Add aft. N.  |
|--------------|--------------|-------|-------|-------|-------|-------|-------|-------|--------------|--------------|
| Sub. bef. N. | Add bef. N.  | 3. 0  | 3. 20 | 3. 40 | 4. 0  | 4. 20 | 4. 40 | 5. 0  | Add bef. N.  | Sub. bef. N. |
| Add in W.    | Sub. in W.   | 45 D. | 50 D. | 55 D. | 60 D. | 65 D. | 70 D. | 75 D. | Sub. in W.   | Add in W.    |
| Sub. in E.   | Add in E.    | Days. | Days. | Days. | Days. | Days. | Days. | Days. | Sub. in E.   | Add in E.    |
| Decem. 21    | Decem. 21    | 0. 0  | 0. 0  | 0. 0  | 0. 0  | 0. 0  | 0. 0  | 0. 0  | 21 June      | 21 June      |
| 20           | 22           | 0. 3  | 0. 3  | 0. 4  | 0. 4  | 0. 4  | 0. 5  | 0. 5  | 22           | 20           |
| 19           | 23           | 0. 6  | 0. 7  | 0. 8  | 0. 9  | 0. 9  | 0. 10 | 0. 11 | 23           | 19           |
| 18           | 24           | 0. 10 | 0. 11 | 0. 12 | 0. 13 | 0. 14 | 0. 15 | 0. 16 | 24           | 18           |
| 17           | 25           | 0. 13 | 0. 15 | 0. 16 | 0. 18 | 0. 19 | 0. 20 | 0. 22 | 25           | 17           |
| 16           | 26           | 0. 16 | 0. 18 | 0. 20 | 0. 22 | 0. 24 | 0. 26 | 0. 27 | 26           | 16           |
| 15           | 27           | 0. 20 | 0. 22 | 0. 24 | 0. 26 | 0. 29 | 0. 31 | 0. 33 | 27           | 15           |
| 14           | 28           | 0. 23 | 0. 25 | 0. 28 | 0. 31 | 0. 34 | 0. 36 | 0. 38 | 28           | 14           |
| 13           | 29           | 0. 26 | 0. 29 | 0. 32 | 0. 35 | 0. 38 | 0. 41 | 0. 44 | 29           | 13           |
| 12           | 30           | 0. 30 | 0. 33 | 0. 36 | 0. 40 | 0. 43 | 0. 46 | 0. 50 | 30 June      | 12           |
| 11           | Decem. 31    | 0. 33 | 0. 37 | 0. 40 | 0. 44 | 0. 48 | 0. 51 | 0. 55 | 1 July       | 11           |
| 10           | Jan. 1       | 0. 36 | 0. 40 | 0. 44 | 0. 48 | 0. 53 | 0. 57 | 1. 1  | 2            | 10           |
| 9            | 2            | 0. 39 | 0. 44 | 0. 48 | 0. 53 | 0. 57 | 1. 2  | 1. 6  | 3            | 9            |
| 8            | 3            | 0. 43 | 0. 48 | 0. 53 | 0. 57 | 1. 2  | 1. 7  | 1. 11 | 4            | 8            |
| 7            | 4            | 0. 46 | 0. 51 | 0. 56 | 1. 1  | 1. 7  | 1. 12 | 1. 17 | 5            | 7            |
| 6            | 5            | 0. 49 | 0. 55 | 1. 0  | 1. 6  | 1. 11 | 1. 17 | 1. 22 | 6            | 6            |
| 5            | 6            | 0. 52 | 0. 58 | 1. 4  | 1. 10 | 1. 16 | 1. 22 | 1. 27 | 7            | 5            |
| 4            | 7            | 0. 55 | 1. 1  | 1. 7  | 1. 14 | 1. 20 | 1. 26 | 1. 32 | 8            | 4            |
| 3            | 8            | 0. 58 | 1. 5  | 1. 11 | 1. 18 | 1. 24 | 1. 31 | 1. 37 | 9            | 3            |
| 2            | 9            | 1. 1  | 1. 8  | 1. 15 | 1. 22 | 1. 29 | 1. 36 | 1. 43 | 10           | 2            |
| Decem. 1     | 10           | 1. 4  | 1. 12 | 1. 19 | 1. 26 | 1. 33 | 1. 41 | 1. 48 | 11           | 1 June       |
| Nov. 30      | 11           | 1. 7  | 1. 15 | 1. 23 | 1. 30 | 1. 37 | 1. 45 | 1. 52 | 12           | 31 May       |
| 29           | 12           | 1. 10 | 1. 18 | 1. 26 | 1. 34 | 1. 42 | 1. 50 | 1. 57 | 13           | 30           |
| 28           | 13           | 1. 13 | 1. 22 | 1. 30 | 1. 38 | 1. 46 | 1. 54 | 2. 2  | 14           | 29           |
| 27           | 14           | 1. 16 | 1. 25 | 1. 34 | 1. 42 | 1. 50 | 1. 58 | 2. 7  | 15           | 28           |
| 26           | 15           | 1. 19 | 1. 28 | 1. 37 | 1. 46 | 1. 55 | 2. 3  | 2. 12 | 16           | 27           |
| 25           | 16           | 1. 22 | 1. 31 | 1. 40 | 1. 49 | 1. 59 | 2. 8  | 2. 17 | 17           | 26           |
| 24           | 17           | 1. 25 | 1. 35 | 1. 44 | 1. 53 | 2. 3  | 2. 12 | 2. 21 | 18           | 25           |
| 23           | 18           | 1. 28 | 1. 38 | 1. 47 | 1. 57 | 2. 7  | 2. 16 | 2. 26 | 19           | 24           |
| 22           | 19           | 1. 30 | 1. 41 | 1. 51 | 2. 1  | 2. 11 | 2. 21 | 2. 31 | 20           | 23           |
| 21           | 20           | 1. 33 | 1. 44 | 1. 54 | 2. 4  | 2. 15 | 2. 25 | 2. 35 | 21           | 22           |
| 20           | 21           | 1. 36 | 1. 47 | 1. 57 | 2. 8  | 2. 19 | 2. 29 | 2. 40 | 22           | 21           |
| 19           | 22           | 1. 39 | 1. 50 | 2. 0  | 2. 11 | 2. 22 | 2. 33 | 2. 44 | 23           | 20           |
| 18           | 23           | 1. 41 | 1. 53 | 2. 4  | 2. 15 | 2. 26 | 2. 37 | 2. 48 | 24           | 19           |
| 17           | 24           | 1. 43 | 1. 55 | 2. 7  | 2. 18 | 2. 30 | 2. 41 | 2. 52 | 25           | 18           |
| 16           | 25           | 1. 46 | 1. 58 | 2. 10 | 2. 21 | 2. 33 | 2. 45 | 2. 56 | 26           | 17           |
| 15           | 26           | 1. 48 | 2. 1  | 2. 13 | 2. 25 | 2. 37 | 2. 49 | 3. 1  | 27           | 16           |
| 14           | 27           | 1. 51 | 2. 4  | 2. 16 | 2. 28 | 2. 40 | 2. 52 | 3. 5  | 28           | 15           |
| 13           | 28           | 1. 54 | 2. 7  | 2. 19 | 2. 31 | 2. 44 | 2. 56 | 3. 9  | 29           | 14           |
| 12           | Jan. 30      | 1. 58 | 2. 11 | 2. 24 | 2. 37 | 2. 51 | 3. 4  | 3. 17 | 31 July      | 12           |
| 9            | Feb. 1       | 2. 3  | 2. 17 | 2. 30 | 2. 43 | 2. 57 | 3. 11 | 3. 24 | 2 Aug.       | 10           |
| 7            | 3            | 2. 7  | 2. 21 | 2. 35 | 2. 49 | 3. 3  | 3. 17 | 3. 32 | 4            | 8            |
| 5            | 5            | 2. 11 | 2. 25 | 2. 40 | 2. 54 | 3. 9  | 3. 23 | 3. 38 | 6            | 6            |
| 3            | 7            | 2. 14 | 2. 29 | 2. 44 | 2. 59 | 3. 14 | 3. 29 | 3. 44 | 8            | 4            |
| Nov. 1       | 9            | 2. 18 | 2. 33 | 2. 49 | 3. 4  | 3. 19 | 3. 35 | 3. 50 | 10           | 2 May        |
| October 30   | 11           | 2. 22 | 2. 38 | 2. 53 | 3. 9  | 3. 25 | 3. 41 | 3. 56 | 12           | 30 April     |
| 28           | 13           | 2. 25 | 2. 41 | 2. 58 | 3. 14 | 3. 30 | 3. 46 | 4. 3  | 14           | 28           |
| 26           | 15           | 2. 29 | 2. 45 | 3. 2  | 3. 18 | 3. 35 | 3. 51 | 4. 8  | 16           | 26           |
| 24           | 17           | 2. 32 | 2. 49 | 3. 5  | 3. 22 | 3. 39 | 3. 56 | 4. 13 | 18           | 24           |
| 21           | 20           | 2. 36 | 2. 53 | 3. 11 | 3. 28 | 3. 45 | 4. 3  | 4. 20 | 21           | 21           |
| 18           | 23           | 2. 40 | 2. 58 | 3. 15 | 3. 33 | 3. 51 | 4. 8  | 4. 26 | 24           | 18           |
| 15           | Feb. 26      | 2. 43 | 3. 1  | 3. 20 | 3. 38 | 3. 56 | 4. 14 | 4. 32 | 27           | 15           |
| 12           | March 1      | 2. 46 | 3. 5  | 3. 23 | 3. 42 | 4. 1  | 4. 19 | 4. 38 | 30 Aug.      | 12           |
| 9            | 4            | 2. 49 | 3. 8  | 3. 26 | 3. 45 | 4. 4  | 4. 23 | 4. 41 | 2 Sept.      | 9            |
| 6            | 7            | 2. 51 | 3. 10 | 3. 29 | 3. 48 | 4. 7  | 4. 26 | 4. 45 | 5            | 6            |
| October 3    | 10           | 2. 53 | 3. 13 | 3. 32 | 3. 51 | 4. 10 | 4. 29 | 4. 49 | 8            | 3 April      |
| Sept. 30     | 13           | 2. 55 | 3. 14 | 3. 33 | 3. 53 | 4. 13 | 4. 32 | 4. 51 | 11           | 31 March     |
| 27           | 16           | 2. 56 | 3. 15 | 3. 34 | 3. 54 | 4. 14 | 4. 33 | 4. 52 | 14           | 27           |
| 24           | 19           | 2. 56 | 3. 15 | 3. 35 | 3. 55 | 4. 15 | 4. 33 | 4. 52 | 17           | 24           |
| 21           | 22           | 2. 56 | 3. 15 | 3. 35 | 3. 55 | 4. 15 | 4. 34 | 4. 53 | 20           | 21           |

Tab. XVIII. For reducing the SUN'S DECLIN. as given in the N. A. for Noon at GREENWICH to any other Time under that Merid. or to Noon under any other Merid.

| Add aft. N.<br>Sub. bef. N. | Sub. aft. N.<br>Add. bef. N. | H. M.<br>5. 20 | H. M.<br>5. 40 | H. M.<br>6. 0 | H. M.<br>6. 20 | H. M.<br>6. 40 | H. M.<br>7. 0 | H. M.<br>7. 20 | Sub. aft. N.<br>Add. bef. N. | Add aft. N.<br>Sub. bef. N. |
|-----------------------------|------------------------------|----------------|----------------|---------------|----------------|----------------|---------------|----------------|------------------------------|-----------------------------|
| Add. in W.<br>Sub. in E.    | Sub. in W.<br>Add. in E.     | D<br>80        | D<br>85        | D<br>90       | D<br>95        | D<br>100       | D<br>105      | D<br>110       | Sub. in W.<br>Add. in E.     | Add. in W.<br>Sub. in E.    |
| Days.                       | Days.                        | M. S.          | M. S.          | M. S.         | M. S.          | M. S.          | M. S.         | M. S.          | Days.                        | Days.                       |
| Decem. 21                   | Decem. 21                    | 0. 0           | 0. 0           | 0. 0          | 0. 0           | 0. 0           | 0. 0          | 0. 0           | 21 June                      | 21 June                     |
| 20                          | 22                           | 0. 5           | 0. 6           | 0. 6          | 0. 7           | 0. 8           | 0. 8          | 0. 8           | 22                           | 20                          |
| 19                          | 23                           | 0. 11          | 0. 12          | 0. 13         | 0. 14          | 0. 15          | 0. 15         | 0. 16          | 23                           | 19                          |
| 18                          | 24                           | 0. 17          | 0. 19          | 0. 20         | 0. 21          | 0. 22          | 0. 23         | 0. 24          | 24                           | 18                          |
| 17                          | 25                           | 0. 23          | 0. 25          | 0. 26         | 0. 28          | 0. 29          | 0. 31         | 0. 32          | 25                           | 17                          |
| 16                          | 26                           | 0. 29          | 0. 31          | 0. 33         | 0. 35          | 0. 37          | 0. 38         | 0. 40          | 26                           | 16                          |
| 15                          | 27                           | 0. 35          | 0. 38          | 0. 40         | 0. 42          | 0. 44          | 0. 46         | 0. 49          | 27                           | 15                          |
| 14                          | 28                           | 0. 41          | 0. 43          | 0. 46         | 0. 49          | 0. 51          | 0. 54         | 0. 57          | 28                           | 14                          |
| 13                          | 29                           | 0. 47          | 0. 50          | 0. 53         | 0. 56          | 0. 59          | 1. 2          | 1. 5           | 29                           | 13                          |
| 12                          | 30                           | 0. 53          | 0. 56          | 0. 59         | 1. 3           | 1. 6           | 1. 9          | 1. 12          | 30 June                      | 12                          |
| 11                          | Decem. 31                    | 0. 59          | 1. 2           | 1. 6          | 1. 10          | 1. 13          | 1. 17         | 1. 21          | 1 July                       | 11                          |
| 10                          | Jan. 1                       | 1. 5           | 1. 9           | 1. 13         | 1. 17          | 1. 21          | 1. 25         | 1. 29          | 2                            | 10                          |
| 9                           | 2                            | 1. 11          | 1. 15          | 1. 19         | 1. 24          | 1. 28          | 1. 32         | 1. 37          | 3                            | 9                           |
| 8                           | 3                            | 1. 16          | 1. 21          | 1. 26         | 1. 31          | 1. 35          | 1. 40         | 1. 45          | 4                            | 8                           |
| 7                           | 4                            | 1. 22          | 1. 27          | 1. 32         | 1. 37          | 1. 42          | 1. 47         | 1. 53          | 5                            | 7                           |
| 6                           | 5                            | 1. 27          | 1. 33          | 1. 38         | 1. 44          | 1. 49          | 1. 54         | 2. 0           | 6                            | 6                           |
| 5                           | 6                            | 1. 33          | 1. 39          | 1. 45         | 1. 51          | 1. 57          | 2. 2          | 2. 8           | 7                            | 5                           |
| 4                           | 7                            | 1. 39          | 1. 45          | 1. 51         | 1. 57          | 2. 3           | 2. 9          | 2. 16          | 8                            | 4                           |
| 3                           | 8                            | 1. 44          | 1. 50          | 1. 57         | 2. 4           | 2. 10          | 2. 16         | 2. 23          | 9                            | 3                           |
| 2                           | 9                            | 1. 50          | 1. 56          | 2. 3          | 2. 10          | 2. 17          | 2. 23         | 2. 30          | 10                           | 2                           |
| Decem. 1                    | 10                           | 1. 55          | 2. 2           | 2. 9          | 2. 16          | 2. 23          | 2. 30         | 2. 38          | 11                           | 1 June                      |
| Nov. 30                     | 11                           | 2. 0           | 2. 7           | 2. 15         | 2. 22          | 2. 30          | 2. 37         | 2. 45          | 12                           | 31 May                      |
| 29                          | 12                           | 2. 5           | 2. 13          | 2. 21         | 2. 29          | 2. 37          | 2. 44         | 2. 52          | 13                           | 30                          |
| 28                          | 13                           | 2. 10          | 2. 19          | 2. 27         | 2. 35          | 2. 43          | 2. 51         | 3. 0           | 14                           | 29                          |
| 27                          | 14                           | 2. 16          | 2. 25          | 2. 33         | 2. 42          | 2. 50          | 2. 58         | 3. 7           | 15                           | 28                          |
| 26                          | 15                           | 2. 21          | 2. 30          | 2. 38         | 2. 47          | 2. 56          | 3. 5          | 3. 13          | 16                           | 27                          |
| 25                          | 16                           | 2. 26          | 2. 35          | 2. 44         | 2. 53          | 3. 2           | 3. 11         | 3. 21          | 17                           | 26                          |
| 24                          | 17                           | 2. 31          | 2. 40          | 2. 50         | 2. 59          | 3. 9           | 3. 18         | 3. 28          | 18                           | 25                          |
| 23                          | 18                           | 2. 36          | 2. 46          | 2. 55         | 3. 5           | 3. 15          | 3. 24         | 3. 34          | 19                           | 24                          |
| 22                          | 19                           | 2. 41          | 2. 51          | 3. 1          | 3. 11          | 3. 21          | 3. 31         | 3. 41          | 20                           | 23                          |
| 21                          | 20                           | 2. 46          | 2. 56          | 3. 6          | 3. 17          | 3. 27          | 3. 37         | 3. 48          | 21                           | 22                          |
| 20                          | 21                           | 2. 50          | 3. 2           | 3. 12         | 3. 23          | 3. 33          | 3. 44         | 3. 55          | 22                           | 21                          |
| 19                          | 22                           | 2. 55          | 3. 6           | 3. 17         | 3. 28          | 3. 39          | 3. 50         | 4. 1           | 23                           | 20                          |
| 18                          | 23                           | 3. 0           | 3. 11          | 3. 22         | 3. 33          | 3. 45          | 3. 56         | 4. 7           | 24                           | 19                          |
| 17                          | 24                           | 3. 4           | 3. 16          | 3. 27         | 3. 39          | 3. 50          | 4. 1          | 4. 13          | 25                           | 18                          |
| 16                          | 25                           | 3. 8           | 3. 20          | 3. 32         | 3. 44          | 3. 56          | 4. 7          | 4. 19          | 26                           | 17                          |
| 15                          | 26                           | 3. 13          | 3. 25          | 3. 37         | 3. 49          | 4. 1           | 4. 13         | 4. 26          | 27                           | 16                          |
| 14                          | 27                           | 3. 17          | 3. 29          | 3. 42         | 3. 54          | 4. 6           | 4. 19         | 4. 31          | 28                           | 15                          |
| 13                          | 28                           | 3. 22          | 3. 34          | 3. 47         | 4. 0           | 4. 12          | 4. 25         | 4. 38          | 29                           | 14                          |
| 11                          | Jan. 30                      | 3. 30          | 3. 43          | 3. 56         | 4. 9           | 4. 22          | 4. 36         | 4. 49          | 31 July                      | 12                          |
| 9                           | Feb. 1                       | 3. 38          | 3. 51          | 4. 5          | 4. 18          | 4. 32          | 4. 46         | 4. 59          | 2 Aug.                       | 10                          |
| 7                           | 3                            | 3. 46          | 4. 0           | 4. 14         | 4. 28          | 4. 42          | 4. 56         | 5. 10          | 4                            | 8                           |
| 5                           | 5                            | 3. 52          | 4. 6           | 4. 21         | 4. 36          | 4. 50          | 5. 5          | 5. 19          | 6                            | 6                           |
| 3                           | 7                            | 3. 59          | 4. 14          | 4. 29         | 4. 44          | 4. 59          | 5. 14         | 5. 29          | 8                            | 4                           |
| Non. 1                      | 9                            | 4. 5           | 4. 21          | 4. 36         | 4. 52          | 5. 7           | 5. 23         | 5. 38          | 10                           | 2 May                       |
| October 30                  | 11                           | 4. 12          | 4. 28          | 4. 44         | 5. 0           | 5. 16          | 5. 31         | 5. 47          | 12                           | 30 April                    |
| 28                          | 13                           | 4. 19          | 4. 35          | 4. 51         | 5. 7           | 5. 23          | 5. 40         | 5. 56          | 14                           | 28                          |
| 26                          | 15                           | 4. 24          | 4. 41          | 4. 57         | 5. 14          | 5. 30          | 5. 47         | 6. 3           | 16                           | 26                          |
| 24                          | 17                           | 4. 30          | 4. 47          | 5. 3          | 5. 21          | 5. 38          | 5. 55         | 6. 12          | 18                           | 24                          |
| 21                          | 20                           | 4. 37          | 4. 55          | 5. 12         | 5. 29          | 5. 47          | 6. 4          | 6. 21          | 21                           | 21                          |
| 18                          | 23                           | 4. 44          | 5. 2           | 5. 19         | 5. 37          | 5. 55          | 6. 13         | 6. 31          | 24                           | 18                          |
| 15                          | Feb. 26                      | 4. 50          | 5. 8           | 5. 26         | 5. 44          | 6. 2           | 6. 20         | 6. 38          | 27                           | 15                          |
| 12                          | March 1                      | 4. 56          | 5. 15          | 5. 33         | 5. 52          | 6. 10          | 6. 29         | 6. 47          | 30 Aug.                      | 12                          |
| 9                           | 4                            | 5. 0           | 5. 19          | 5. 38         | 5. 57          | 6. 16          | 6. 34         | 6. 53          | 2 Sept.                      | 9                           |
| 6                           | 7                            | 5. 4           | 5. 20          | 5. 42         | 6. 1           | 6. 20          | 6. 39         | 6. 58          | 5                            | 6                           |
| October 3                   | 10                           | 5. 8           | 5. 27          | 5. 46         | 6. 5           | 6. 25          | 6. 44         | 7. 3           | 8                            | 3 April                     |
| Septem. 30                  | 13                           | 5. 11          | 5. 30          | 5. 49         | 6. 8           | 6. 28          | 6. 47         | 7. 6           | 11                           | 31 March                    |
| 27                          | 16                           | 5. 12          | 5. 31          | 5. 51         | 6. 11          | 6. 31          | 6. 50         | 7. 9           | 14                           | 28                          |
| 24                          | 19                           | 5. 12          | 5. 32          | 5. 52         | 6. 12          | 6. 32          | 6. 51         | 7. 11          | 17                           | 25                          |
| 21                          | 22                           | 5. 13          | 5. 33          | 5. 53         | 6. 13          | 6. 33          | 6. 52         | 7. 11          | 20                           | 22                          |



TAB. XVIII. For reducing the SUN'S DECLIN. as given in the N. A. for Noon GREENWICH to any other Time under that Merid. or to Noon under any other Merid

| Sub. aft. N | Sub. bef. N | Add. in W. | Sub. in E. | Days. | Sub. aft. N | Sub. bef. N | Add. in W. | Sub. in E. | Days.     | Sub. aft. N | Sub. bef. N | Add. in W. | Sub. in E. | Days.    |
|-------------|-------------|------------|------------|-------|-------------|-------------|------------|------------|-----------|-------------|-------------|------------|------------|----------|
| Sub. aft. N | Add. bef. N | D          | D          | M. S. | Sub. aft. N | Add. bef. N | D          | D          | M. S.     | Sub. aft. N | Add. bef. N | D          | D          | M. S.    |
| 7. 40       | 8. 0        | 8. 20      | 8. 40      | 9. 0  | 9. 20       | 9. 40       | 115        | 120        | 125       | 130         | 135         | 140        | 145        | Days     |
| Decem. 21   | Decem. 21   | 0. 0       | 0. 0       | 0. 0  | 0. 0        | 0. 0        | 0. 0       | 0. 0       | 0. 0      | 0. 0        | 0. 0        | 0. 0       | 0. 0       | 21 June  |
| 20          | 22          | 0. 9       | 0. 9       | 0. 9  | 0. 10       | 0. 10       | 0. 10      | 0. 10      | 0. 10     | 0. 10       | 0. 10       | 0. 10      | 0. 10      | 22       |
| 19          | 23          | 0. 17      | 0. 18      | 0. 18 | 0. 19       | 0. 19       | 0. 20      | 0. 21      | 0. 21     | 0. 21       | 0. 21       | 0. 21      | 0. 21      | 23       |
| 18          | 24          | 0. 25      | 0. 26      | 0. 27 | 0. 28       | 0. 29       | 0. 30      | 0. 31      | 0. 31     | 0. 31       | 0. 31       | 0. 31      | 0. 31      | 24       |
| 17          | 25          | 0. 34      | 0. 35      | 0. 36 | 0. 38       | 0. 39       | 0. 41      | 0. 43      | 0. 43     | 0. 43       | 0. 43       | 0. 43      | 0. 43      | 25       |
| 16          | 26          | 0. 42      | 0. 44      | 0. 46 | 0. 48       | 0. 49       | 0. 51      | 0. 53      | 0. 53     | 0. 53       | 0. 53       | 0. 53      | 0. 53      | 26       |
| 15          | 27          | 0. 51      | 0. 53      | 0. 55 | 0. 57       | 0. 59       | 1. 1       | 1. 3       | 1. 3      | 1. 3        | 1. 3        | 1. 3       | 1. 3       | 27       |
| 14          | 28          | 0. 59      | 1. 2       | 1. 5  | 1. 7        | 1. 9        | 1. 12      | 1. 14      | 1. 14     | 1. 14       | 1. 14       | 1. 14      | 1. 14      | 28       |
| 13          | 29          | 1. 8       | 1. 11      | 1. 14 | 1. 17       | 1. 19       | 1. 22      | 1. 25      | 1. 25     | 1. 25       | 1. 25       | 1. 25      | 1. 25      | 29       |
| 12          | 30          | 1. 16      | 1. 19      | 1. 23 | 1. 26       | 1. 29       | 1. 32      | 1. 35      | 1. 35     | 1. 35       | 1. 35       | 1. 35      | 1. 35      | 30 June  |
| 11          | Decem. 31   | 1. 24      | 1. 28      | 1. 32 | 1. 35       | 1. 39       | 1. 43      | 1. 46      | 1. 46     | 1. 46       | 1. 46       | 1. 46      | 1. 46      | 1 July   |
| 10          | Jan. 1      | 1. 33      | 1. 37      | 1. 41 | 1. 45       | 1. 49       | 1. 53      | 1. 57      | 2         | 2           | 2           | 2          | 2          | 10       |
| 9           | 2           | 1. 42      | 1. 46      | 1. 51 | 1. 55       | 1. 59       | 2. 3       | 2. 7       | 3         | 3           | 3           | 3          | 3          | 9        |
| 8           | 3           | 1. 49      | 1. 54      | 1. 59 | 2. 4        | 2. 9        | 2. 13      | 2. 18      | 4         | 4           | 4           | 4          | 4          | 8        |
| 7           | 4           | 1. 58      | 2. 3       | 2. 8  | 2. 13       | 2. 19       | 2. 23      | 2. 28      | 5         | 5           | 5           | 5          | 5          | 7        |
| 6           | 5           | 2. 5       | 2. 11      | 2. 16 | 2. 22       | 2. 28       | 2. 33      | 2. 39      | 6         | 6           | 6           | 6          | 6          | 6        |
| 5           | 6           | 2. 14      | 2. 20      | 2. 26 | 2. 32       | 2. 38       | 2. 43      | 2. 49      | 7         | 7           | 7           | 7          | 7          | 5        |
| 4           | 7           | 2. 22      | 2. 28      | 2. 34 | 2. 41       | 2. 47       | 2. 53      | 2. 59      | 8         | 8           | 8           | 8          | 8          | 4        |
| 3           | 8           | 2. 29      | 2. 36      | 2. 43 | 2. 49       | 2. 56       | 3. 3       | 3. 9       | 9         | 9           | 9           | 9          | 9          | 3        |
| 2           | 9           | 2. 37      | 2. 44      | 2. 51 | 2. 58       | 3. 5        | 3. 12      | 3. 19      | 10        | 10          | 10          | 10         | 10         | 2        |
| Decem. 1    | 10          | 2. 45      | 2. 52      | 2. 59 | 3. 6        | 3. 14       | 3. 21      | 3. 28      | 11        | 11          | 11          | 11         | 11         | 1 June   |
| Novem. 30   | 11          | 2. 52      | 3. 0       | 3. 7  | 3. 15       | 3. 23       | 3. 30      | 3. 38      | 12        | 12          | 12          | 12         | 12         | 31 May   |
| 29          | 12          | 3. 0       | 3. 8       | 3. 16 | 3. 24       | 3. 32       | 3. 39      | 3. 47      | 13        | 13          | 13          | 13         | 13         | 30       |
| 28          | 13          | 3. 8       | 3. 16      | 3. 24 | 3. 32       | 3. 40       | 3. 49      | 3. 57      | 14        | 14          | 14          | 14         | 14         | 29       |
| 27          | 14          | 3. 15      | 3. 24      | 3. 32 | 3. 41       | 3. 49       | 3. 58      | 4. 6       | 15        | 15          | 15          | 15         | 15         | 28       |
| 26          | 15          | 3. 22      | 3. 31      | 3. 40 | 3. 49       | 3. 58       | 4. 7       | 4. 16      | 16        | 16          | 16          | 16         | 16         | 27       |
| 25          | 16          | 3. 30      | 3. 39      | 3. 48 | 3. 57       | 4. 7        | 4. 16      | 4. 25      | 17        | 17          | 17          | 17         | 17         | 26       |
| 24          | 17          | 3. 37      | 3. 46      | 3. 56 | 4. 6        | 4. 16       | 4. 24      | 4. 34      | 18        | 18          | 18          | 18         | 18         | 25       |
| 23          | 18          | 3. 44      | 3. 54      | 4. 4  | 4. 14       | 4. 24       | 4. 33      | 4. 43      | 19        | 19          | 19          | 19         | 19         | 24       |
| 22          | 19          | 3. 51      | 4. 1       | 4. 11 | 4. 21       | 4. 31       | 4. 41      | 4. 51      | 20        | 20          | 20          | 20         | 20         | 23       |
| 21          | 20          | 3. 58      | 4. 8       | 4. 19 | 4. 29       | 4. 39       | 4. 50      | 5. 0       | 21        | 21          | 21          | 21         | 21         | 22       |
| 20          | 21          | 4. 5       | 4. 16      | 4. 27 | 4. 37       | 4. 48       | 4. 59      | 5. 9       | 22        | 22          | 22          | 22         | 22         | 21       |
| 19          | 22          | 4. 12      | 4. 23      | 4. 34 | 4. 45       | 4. 56       | 5. 7       | 5. 18      | 23        | 23          | 23          | 23         | 23         | 20       |
| 18          | 23          | 4. 19      | 4. 30      | 4. 41 | 4. 53       | 5. 4        | 5. 15      | 5. 26      | 24        | 24          | 24          | 24         | 24         | 19       |
| 17          | 24          | 4. 25      | 4. 36      | 4. 48 | 5. 0        | 5. 12       | 5. 23      | 5. 34      | 25        | 25          | 25          | 25         | 25         | 18       |
| 16          | 25          | 4. 31      | 4. 43      | 4. 55 | 5. 7        | 5. 19       | 5. 30      | 5. 42      | 26        | 26          | 26          | 26         | 26         | 17       |
| 15          | 26          | 4. 38      | 4. 50      | 5. 2  | 5. 14       | 5. 26       | 5. 38      | 5. 50      | 27        | 27          | 27          | 27         | 27         | 16       |
| 14          | 27          | 4. 43      | 4. 56      | 5. 8  | 5. 21       | 5. 33       | 5. 46      | 5. 58      | 28        | 28          | 28          | 28         | 28         | 15       |
| 13          | 28          | 4. 50      | 5. 3       | 5. 16 | 5. 28       | 5. 40       | 5. 54      | 6. 6       | 29        | 29          | 29          | 29         | 29         | 14       |
| 11          | Jan. 30     | 5. 2       | 5. 15      | 5. 28 | 5. 41       | 5. 54       | 6. 8       | 6. 21      | 31 July   | 31          | 31          | 31         | 31         | 12       |
| 9           | Feb. 1      | 5. 13      | 5. 27      | 5. 40 | 5. 54       | 6. 8        | 6. 22      | 6. 35      | 2 Aug.    | 2           | 2           | 2          | 2          | 10       |
| 7           | 3           | 5. 24      | 5. 38      | 5. 52 | 6. 6        | 6. 20       | 6. 35      | 6. 49      | 4         | 4           | 4           | 4          | 4          | 8        |
| 5           | 5           | 5. 34      | 5. 49      | 6. 4  | 6. 18       | 6. 33       | 6. 47      | 7. 2       | 6         | 6           | 6           | 6          | 6          | 6        |
| 3           | 7           | 5. 44      | 5. 59      | 6. 14 | 6. 29       | 6. 44       | 6. 59      | 7. 14      | 8         | 8           | 8           | 8          | 8          | 4        |
| Novem. 1    | 9           | 5. 53      | 6. 9       | 6. 24 | 6. 40       | 6. 55       | 7. 11      | 7. 26      | 10        | 10          | 10          | 10         | 10         | 3 May    |
| October 30  | 11          | 6. 3       | 6. 18      | 6. 34 | 6. 50       | 7. 6        | 7. 21      | 7. 37      | 12        | 12          | 12          | 12         | 12         | 30 April |
| 28          | 13          | 6. 12      | 6. 28      | 6. 44 | 7. 0        | 7. 16       | 7. 32      | 7. 48      | 14        | 14          | 14          | 14         | 14         | 28       |
| 26          | 15          | 6. 20      | 6. 36      | 6. 53 | 7. 10       | 7. 26       | 7. 42      | 7. 58      | 16        | 16          | 16          | 16         | 16         | 26       |
| 24          | 17          | 6. 29      | 6. 45      | 7. 2  | 7. 19       | 7. 36       | 7. 52      | 8. 9       | 18        | 18          | 18          | 18         | 18         | 24       |
| 21          | 20          | 6. 39      | 6. 56      | 7. 13 | 7. 31       | 7. 48       | 8. 5       | 8. 22      | 21        | 21          | 21          | 21         | 21         | 21       |
| 18          | 23          | 6. 48      | 7. 6       | 7. 24 | 7. 42       | 8. 0        | 8. 17      | 8. 34      | 24        | 24          | 24          | 24         | 24         | 18       |
| 15          | Feb. 26     | 6. 57      | 7. 15      | 7. 34 | 7. 52       | 8. 10       | 8. 28      | 8. 46      | 27        | 27          | 27          | 27         | 27         | 15       |
| 12          | March 1     | 7. 6       | 7. 24      | 7. 42 | 8. 1        | 8. 20       | 8. 38      | 8. 57      | 30 Aug.   | 30          | 30          | 30         | 30         | 12       |
| 9           | 4           | 7. 12      | 7. 31      | 7. 50 | 8. 9        | 8. 28       | 8. 46      | 9. 6       | 2 Septem. | 2           | 2           | 2          | 2          | 9        |
| 6           | 7           | 7. 17      | 7. 36      | 7. 55 | 8. 14       | 8. 33       | 8. 53      | 9. 12      | 5         | 5           | 5           | 5          | 5          | 6        |
| October 3   | 10          | 7. 23      | 7. 42      | 8. 1  | 8. 20       | 8. 39       | 8. 59      | 9. 18      | 8         | 8           | 8           | 8          | 8          | 3 April  |
| Sept. 30    | 13          | 7. 26      | 7. 45      | 8. 4  | 8. 24       | 8. 43       | 9. 3       | 9. 22      | 11        | 11          | 11          | 11         | 11         | 31 March |
| 27          | 16          | 7. 29      | 7. 48      | 8. 7  | 8. 27       | 8. 47       | 9. 6       | 9. 25      | 14        | 14          | 14          | 14         | 14         | 28       |
| 24          | 19          | 7. 30      | 7. 50      | 8. 10 | 8. 29       | 8. 49       | 9. 8       | 9. 27      | 17        | 17          | 17          | 17         | 17         | 25       |
| 21          | 22          | 7. 31      | 7. 50      | 8. 10 | 8. 30       | 8. 50       | 9. 9       | 9. 28      | 20        | 20          | 20          | 20         | 20         | 22       |

TAB. XVIII. For reducing the SUN's DECLIN. as given in the N. A. for Noon at GREENWICH to any other Time under that Merid. or to Noon under any other Merid.

| Ad. af. N.   | Sub. af. N. | H. M. | H. M.  | H. M.  | H. M.  | H. M.  | H. M.  | H. M.  | H. M.       | Sub. af. N.  | Ad. af. N. |
|--------------|-------------|-------|--------|--------|--------|--------|--------|--------|-------------|--------------|------------|
| Sub. bef. N. | Add bef. N. | 10. 0 | 10. 20 | 10. 40 | 11. 0  | 11. 20 | 11. 40 | 12. 0  | Add bef. N. | Sub. bef. N. |            |
| Add in W.    | Sub. in W.  | D     | D      | D      | D      | D      | D      | D      | Sub. in W.  | Add in W.    |            |
| Sub. in E.   | Add in E.   | 150   | 155    | 160    | 165    | 170    | 175    | 180    | Add in E.   | Sub. in E.   |            |
| Days         | Days        | M. s. | M. s.  | M. s.  | M. s.  | M. s.  | M. s.  | M. s.  | Days        | Days         |            |
| Decem. 21    | Decem. 21   | 0. 0  | 0. 0   | 0. 0   | 0. 0   | 0. 0   | 0. 0   | 0. 0   | 21 June     | 21 June      |            |
| 20           | 22          | 0. 11 | 0. 11  | 0. 12  | 0. 12  | 0. 12  | 0. 13  | 0. 13  | 22          | 20           |            |
| 19           | 23          | 0. 22 | 0. 23  | 0. 24  | 0. 24  | 0. 25  | 0. 26  | 0. 26  | 23          | 19           |            |
| 18           | 24          | 0. 33 | 0. 34  | 0. 35  | 0. 36  | 0. 37  | 0. 38  | 0. 39  | 24          | 18           |            |
| 17           | 25          | 0. 44 | 0. 46  | 0. 47  | 0. 48  | 0. 50  | 0. 51  | 0. 53  | 25          | 17           |            |
| 16           | 26          | 0. 55 | 0. 57  | 0. 58  | 1. 0   | 1. 2   | 1. 4   | 1. 6   | 26          | 16           |            |
| 15           | 27          | 1. 6  | 1. 8   | 1. 11  | 1. 13  | 1. 15  | 1. 17  | 1. 19  | 27          | 15           |            |
| 14           | 28          | 1. 17 | 1. 20  | 1. 23  | 1. 25  | 1. 27  | 1. 30  | 1. 32  | 28          | 14           |            |
| 13           | 29          | 1. 28 | 1. 30  | 1. 34  | 1. 37  | 1. 40  | 1. 43  | 1. 46  | 29          | 13           |            |
| 12           | 30          | 1. 39 | 1. 42  | 1. 45  | 1. 49  | 1. 52  | 1. 55  | 1. 59  | 30          | 12           |            |
| 11           | Decem. 31   | 1. 50 | 1. 54  | 1. 57  | 2. 1   | 2. 5   | 2. 8   | 2. 12  | 1 July      | 11           |            |
| 10           | Jan. 1      | 2. 1  | 2. 5   | 2. 9   | 2. 13  | 2. 17  | 2. 21  | 2. 25  | 2           | 10           |            |
| 9            | 2           | 2. 12 | 2. 16  | 2. 20  | 2. 25  | 2. 30  | 2. 34  | 2. 38  | 3           | 9            |            |
| 8            | 3           | 2. 23 | 2. 27  | 2. 32  | 2. 37  | 2. 42  | 2. 47  | 2. 51  | 4           | 8            |            |
| 7            | 4           | 2. 34 | 2. 39  | 2. 44  | 2. 49  | 2. 54  | 2. 59  | 3. 4   | 5           | 7            |            |
| 6            | 5           | 2. 44 | 2. 50  | 2. 55  | 3. 0   | 3. 6   | 3. 12  | 3. 17  | 6           | 6            |            |
| 5            | 6           | 2. 55 | 3. 1   | 3. 6   | 3. 12  | 3. 18  | 3. 24  | 3. 30  | 7           | 5            |            |
| 4            | 7           | 3. 5  | 3. 11  | 3. 17  | 3. 23  | 3. 29  | 3. 36  | 3. 42  | 8           | 4            |            |
| 3            | 8           | 3. 15 | 3. 21  | 3. 28  | 3. 34  | 3. 41  | 3. 48  | 3. 54  | 9           | 3            |            |
| 2            | 9           | 3. 25 | 3. 32  | 3. 38  | 3. 45  | 3. 52  | 3. 59  | 4. 6   | 10          | 2            |            |
| Decem. 1     | 10          | 3. 35 | 3. 42  | 3. 49  | 3. 56  | 4. 4   | 4. 11  | 4. 18  | 11          | 1 June       |            |
| Novem. 30    | 11          | 3. 45 | 3. 52  | 3. 59  | 4. 7   | 4. 15  | 4. 22  | 4. 30  | 12          | 31 May       |            |
| 29           | 12          | 3. 55 | 4. 3   | 4. 10  | 4. 18  | 4. 26  | 4. 34  | 4. 42  | 13          | 30           |            |
| 28           | 13          | 4. 5  | 4. 13  | 4. 21  | 4. 29  | 4. 38  | 4. 46  | 4. 54  | 14          | 29           |            |
| 27           | 14          | 4. 15 | 4. 23  | 4. 31  | 4. 40  | 4. 49  | 4. 57  | 5. 5   | 15          | 28           |            |
| 26           | 15          | 4. 24 | 4. 33  | 4. 41  | 4. 50  | 4. 59  | 5. 8   | 5. 17  | 16          | 27           |            |
| 25           | 16          | 4. 34 | 4. 43  | 4. 52  | 5. 1   | 5. 10  | 5. 19  | 5. 28  | 17          | 26           |            |
| 24           | 17          | 4. 43 | 4. 53  | 5. 2   | 5. 11  | 5. 21  | 5. 30  | 5. 40  | 18          | 25           |            |
| 23           | 18          | 4. 5  | 5. 2   | 5. 12  | 5. 22  | 5. 32  | 5. 41  | 5. 51  | 19          | 24           |            |
| 22           | 19          | 5. 1  | 5. 12  | 5. 22  | 5. 32  | 5. 42  | 5. 52  | 6. 2   | 20          | 23           |            |
| 21           | 20          | 5. 10 | 5. 21  | 5. 31  | 5. 42  | 5. 53  | 6. 3   | 6. 13  | 21          | 22           |            |
| 20           | 21          | 5. 20 | 5. 31  | 5. 41  | 5. 52  | 6. 3   | 6. 14  | 6. 24  | 22          | 21           |            |
| 19           | 22          | 5. 29 | 5. 40  | 5. 51  | 6. 2   | 6. 13  | 6. 24  | 6. 34  | 23          | 20           |            |
| 18           | 23          | 5. 37 | 5. 49  | 6. 0   | 6. 11  | 6. 23  | 6. 34  | 6. 44  | 24          | 19           |            |
| 17           | 24          | 5. 45 | 5. 57  | 6. 9   | 6. 20  | 6. 32  | 6. 43  | 6. 54  | 25          | 18           |            |
| 16           | 25          | 5. 54 | 6. 6   | 6. 17  | 6. 29  | 6. 41  | 6. 53  | 7. 4   | 26          | 17           |            |
| 15           | 26          | 6. 2  | 6. 14  | 6. 26  | 6. 38  | 6. 51  | 7. 3   | 7. 14  | 27          | 16           |            |
| 14           | 27          | 6. 10 | 6. 22  | 6. 34  | 6. 47  | 7. 0   | 7. 12  | 7. 24  | 28          | 15           |            |
| 13           | 28          | 6. 19 | 6. 31  | 6. 43  | 6. 56  | 7. 9   | 7. 22  | 7. 34  | 29          | 14           |            |
| 11           | Jan. 30     | 6. 34 | 6. 47  | 7. 0   | 7. 13  | 7. 26  | 7. 40  | 7. 53  | 31 July     | 12           |            |
| 9            | Feb. 1      | 6. 49 | 7. 3   | 7. 16  | 7. 30  | 7. 43  | 7. 57  | 8. 11  | 2 August    | 10           |            |
| 7            | 3           | 7. 3  | 7. 17  | 7. 31  | 7. 45  | 7. 59  | 8. 13  | 8. 28  | 4           | 8            |            |
| 5            | 5           | 7. 16 | 7. 31  | 7. 45  | 8. 0   | 8. 14  | 8. 28  | 8. 43  | 6           | 6            |            |
| 3            | 7           | 7. 29 | 7. 44  | 7. 59  | 8. 14  | 8. 28  | 8. 43  | 8. 58  | 8           | 4            |            |
| Novem. 1     | 9           | 7. 41 | 7. 56  | 8. 12  | 8. 27  | 8. 42  | 8. 58  | 9. 13  | 10          | 2 May        |            |
| October 30   | 11          | 7. 53 | 8. 8   | 8. 24  | 8. 40  | 8. 56  | 9. 12  | 9. 28  | 12          | 30 April     |            |
| 28           | 13          | 8. 4  | 8. 20  | 8. 36  | 8. 53  | 9. 9   | 9. 21  | 9. 42  | 14          | 28           |            |
| 26           | 15          | 8. 15 | 8. 32  | 8. 48  | 9. 5   | 9. 21  | 9. 38  | 9. 54  | 16          | 26           |            |
| 24           | 17          | 8. 26 | 8. 43  | 9. 0   | 9. 17  | 9. 34  | 9. 50  | 10. 7  | 18          | 24           |            |
| 21           | 20          | 8. 40 | 8. 57  | 9. 14  | 9. 32  | 9. 49  | 10. 6  | 10. 24 | 21          | 21           |            |
| 18           | 23          | 8. 52 | 9. 10  | 9. 28  | 9. 46  | 10. 3  | 10. 21 | 10. 39 | 24          | 18           |            |
| 15           | Feb. 26     | 9. 4  | 9. 22  | 9. 40  | 9. 58  | 10. 16 | 10. 34 | 10. 53 | 27          | 15           |            |
| 12           | March 1     | 9. 15 | 9. 33  | 9. 51  | 10. 10 | 10. 29 | 10. 47 | 11. 6  | 30 August   | 12           |            |
| 9            | 4           | 9. 24 | 9. 43  | 10. 1  | 10. 20 | 10. 39 | 10. 58 | 11. 16 | 2 Septem.   | 9            |            |
| 6            | 7           | 9. 30 | 9. 50  | 10. 9  | 10. 28 | 10. 47 | 11. 6  | 11. 24 | 5           | 6            |            |
| October 3    | 10          | 9. 37 | 9. 56  | 10. 16 | 10. 35 | 10. 54 | 11. 13 | 11. 32 | 8           | 3 April      |            |
| Septem. 30   | 13          | 9. 41 | 10. 0  | 10. 21 | 10. 40 | 10. 59 | 11. 18 | 11. 38 | 11          | 31 March     |            |
| 27           | 16          | 9. 45 | 10. 4  | 10. 24 | 10. 44 | 11. 3  | 11. 22 | 11. 42 | 14          | 28           |            |
| 24           | 19          | 9. 47 | 10. 6  | 10. 26 | 10. 46 | 11. 5  | 11. 24 | 11. 44 | 17          | 25           |            |
| 21           | 22          | 9. 48 | 10. 7  | 10. 27 | 10. 47 | 11. 6  | 11. 25 | 11. 45 | 20          | 22           |            |

## A T A B L E

OF THE

## SUN'S RIGHT ASCENSION.

| Days. | Jan.  | Feb.  | Mar.  | April | May   | June  | July  | Aug.  | Sept. | Oct.  | Nov.  | Dec.  | Days. |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|       | South | South | South | North | North | North | North | North | North | South | South | South |       |
|       | H. M. | H. M. | H. M. | H. M. | H. M. | H. M. | H. M. | H. M. | H. M. | H. M. | H. M. | H. M. |       |
| 1     | 18 48 | 21 0  | 22 49 | 0 43  | 2 34  | 4 36  | 6 41  | 8 46  | 10 42 | 12 30 | 14 26 | 16 30 | 1     |
| 2     | 18 52 | 21 4  | 22 53 | 0 46  | 2 38  | 4 41  | 6 45  | 8 49  | 10 45 | 12 33 | 14 30 | 16 34 | 2     |
| 3     | 18 57 | 21 8  | 22 57 | 0 50  | 2 41  | 4 45  | 6 49  | 8 53  | 10 49 | 12 37 | 14 34 | 16 39 | 3     |
| 4     | 19 1  | 21 12 | 23 1  | 0 53  | 2 45  | 4 49  | 6 53  | 8 57  | 10 52 | 12 41 | 14 38 | 16 43 | 4     |
| 5     | 19 6  | 21 16 | 23 4  | 0 57  | 2 49  | 4 53  | 6 57  | 9 1   | 10 56 | 12 44 | 14 42 | 16 47 | 5     |
| 6     | 19 10 | 21 20 | 23 8  | 1 1   | 2 53  | 4 56  | 7 1   | 9 5   | 11 0  | 12 48 | 14 46 | 16 52 | 6     |
| 7     | 19 14 | 21 24 | 23 11 | 1 4   | 2 57  | 5 1   | 7 5   | 9 9   | 11 3  | 12 52 | 14 50 | 16 56 | 7     |
| 8     | 19 19 | 21 28 | 23 15 | 1 8   | 3 1   | 5 5   | 7 10  | 9 12  | 11 7  | 12 55 | 14 54 | 17 0  | 8     |
| 9     | 19 23 | 21 32 | 23 19 | 1 12  | 3 5   | 5 9   | 7 14  | 9 16  | 11 11 | 12 59 | 14 58 | 17 5  | 9     |
| 10    | 19 27 | 21 36 | 23 22 | 1 15  | 3 8   | 5 13  | 7 18  | 9 20  | 11 14 | 13 3  | 15 2  | 17 9  | 10    |
| 11    | 19 32 | 21 40 | 23 26 | 1 19  | 3 12  | 5 18  | 7 22  | 9 24  | 11 18 | 13 6  | 15 6  | 17 14 | 11    |
| 12    | 19 36 | 21 44 | 23 30 | 1 23  | 3 16  | 5 22  | 7 26  | 9 28  | 11 21 | 13 10 | 15 10 | 17 18 | 12    |
| 13    | 19 40 | 21 48 | 23 33 | 1 26  | 3 20  | 5 26  | 7 30  | 9 31  | 11 25 | 13 14 | 15 14 | 17 23 | 13    |
| 14    | 19 45 | 21 52 | 23 37 | 1 30  | 3 24  | 5 30  | 7 34  | 9 35  | 11 28 | 13 17 | 15 18 | 17 27 | 14    |
| 15    | 19 49 | 21 56 | 23 41 | 1 34  | 3 28  | 5 34  | 7 38  | 9 39  | 11 32 | 13 21 | 15 22 | 17 31 | 15    |
| 16    | 19 53 | 22 0  | 23 44 | 1 37  | 3 32  | 5 38  | 7 42  | 9 43  | 11 36 | 13 25 | 15 26 | 17 36 | 16    |
| 17    | 19 58 | 22 4  | 23 48 | 1 41  | 3 36  | 5 43  | 7 46  | 9 46  | 11 39 | 13 29 | 15 31 | 17 40 | 17    |
| 18    | 20 2  | 22 7  | 23 52 | 1 45  | 3 40  | 5 47  | 7 50  | 9 50  | 11 43 | 13 32 | 15 35 | 17 45 | 18    |
| 19    | 20 6  | 22 11 | 23 55 | 1 49  | 3 44  | 5 51  | 7 54  | 9 54  | 11 46 | 13 36 | 15 39 | 17 49 | 19    |
| 20    | 20 10 | 22 15 | 23 59 | 1 52  | 3 48  | 5 55  | 7 58  | 9 58  | 11 50 | 13 40 | 15 43 | 17 54 | 20    |
| 21    | 20 14 | 22 19 | 0 3   | 1 56  | 3 52  | 5 59  | 8 2   | 10 1  | 11 54 | 13 44 | 15 47 | 17 58 | 21    |
| 22    | 20 19 | 22 23 | 0 6   | 2 0   | 3 56  | 6 3   | 8 6   | 10 5  | 11 57 | 13 47 | 15 52 | 18 2  | 22    |
| 23    | 20 23 | 22 26 | 0 10  | 2 3   | 4 0   | 6 7   | 8 10  | 10 9  | 12 1  | 13 51 | 15 56 | 18 7  | 23    |
| 24    | 20 27 | 22 30 | 0 13  | 2 7   | 4 4   | 6 12  | 8 14  | 10 12 | 12 4  | 13 55 | 16 0  | 18 11 | 24    |
| 25    | 20 31 | 22 34 | 0 17  | 2 11  | 4 8   | 6 16  | 8 18  | 10 16 | 12 8  | 13 59 | 16 4  | 18 16 | 25    |
| 26    | 20 35 | 22 38 | 0 21  | 2 15  | 4 12  | 6 20  | 8 22  | 10 20 | 12 12 | 14 3  | 16 9  | 18 20 | 26    |
| 27    | 20 40 | 22 42 | 0 24  | 2 19  | 4 16  | 6 24  | 8 26  | 10 23 | 12 15 | 14 7  | 16 13 | 18 25 | 27    |
| 28    | 20 44 | 22 45 | 0 28  | 2 22  | 4 20  | 6 28  | 8 30  | 10 27 | 12 19 | 14 10 | 16 17 | 18 29 | 28    |
| 29    | 20 48 |       | 0 32  | 2 26  | 4 24  | 6 32  | 8 34  | 10 31 | 12 22 | 14 14 | 16 21 | 18 34 | 29    |
| 30    | 20 52 |       | 0 35  | 2 30  | 4 28  | 6 37  | 8 38  | 10 34 | 12 26 | 14 18 | 16 26 | 18 38 | 30    |
| 31    | 20 56 |       | 0 39  |       | 4 32  |       | 8 42  | 10 38 |       | 14 22 |       | 18 42 | 31    |

This table is sufficiently exact for finding when any star comes to the meridian, in order to obtain the latitude; but in all calculations for determining the longitude by celestial observations, the sun's right ascension and declination must be taken out of the Nautical Almanac, as they are there calculated to a greater degree of accuracy.

If the  
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conds, a



TABLE XX.

A TABLE of the Right Ascension and Declination of some of the principal fixed Stars, adapted to the Year 1796, with their Annual Variation.

| Names of the Stars.                             | No. | Right Ascension. | Annual Vari. | Declination | Annual Vari. |
|-------------------------------------------------|-----|------------------|--------------|-------------|--------------|
|                                                 |     | H. M. S.         | S. T.        | ° ' "       | S. T.        |
| Shedar in the breast of Cassiopeia              | 3   | 0 28 51          | +3.31        | 55 25 5 N   | 19.91+       |
| Abnubbabar, pole star, tail of the Little Bear  | 2   | 0 50 24          | 10.05        | 88 13 13    | 19.69+       |
| Mirach, in the girdle of Andromeda              | 2   | 0 58 22          | 3.30         | 34 32 7     | 19.45+       |
| Almaach, in the foot of Andromeda               | 2   | 1 51 27          | 3.62         | 41 20 38    | 17.80+       |
| Menkar, in the jaw of the Whale                 | 2   | 2 51 38          | 3.13         | 3 16 52     | 14.80+       |
| Algol, in the head of Medusa                    | 2   | 2 54 57          | 3.85         | 40 9 31     | 14.63+       |
| Algenib, the bright star in Perseus             | 2   | 3 9 50           | 4.20         | 49 7 23     | 13.72+       |
| Pleiades, the bright star in Taurus             | 3   | 3 35 24          | 3.55         | 23 27 50    | 12.00+       |
| Hyades, in Taurus                               | 3   | 4 8 12           | 3.39         | 15 7 24     | 9.60+        |
| Aldebaran, the Bull's south eye                 | 1   | 4 24 14          | 3.43         | 16 5 19     | 8.32+        |
| Capella, in the Goat                            | 1   | 5 1 40           | 4.40         | 45 46 12    | 5.30+        |
| Bellatrix, in the west shoulder of Orion        | 2   | 5 14 12          | 3.22         | 6 9 8       | 4.15+        |
| Betelgeuse, in the east shoulder of Orion       | 1   | 5 44 8           | 3.25         | 7 21 21     | 1.58+        |
| Castor, the bright star in the head of Gemini   | 2   | 7 21 35          | 3.88         | 32 19 20    | 6.78-        |
| Procyon, the bright star in the Little Dog      | 1   | 7 28 39          | 3.20         | 5 44 58     | 7.40-        |
| Pollux, in the head of Gemini                   | 2   | 7 31 52          | 3.75         | 28 30 26    | 7.70-        |
| Acubens, in the claw of Cancer                  | 3   | 8 47 19          | 3.24         | 12 38 18    | 13.30-       |
| Regulus, in the Lion's Heart                    | 1   | 9 57 31          | 3.24         | 12 57 32    | 17.16-       |
| Dubhe, upper Pointer in the Great Bear          | 2   | 10 51 2          | 3.88         | 62 51 0     | 19.09-       |
| Alioth, the first in the tail of the Great Bear | 2   | 12 45 6          | 2.69         | 57 4 10     | 19.69-       |
| Benetnach, last in the tail of the Great Bear   | 2   | 13 39 31         | 2.41         | 50 20 11    | 18.24-       |
| Arcturus, in Bootes                             | 1   | 14 6 25          | 2.82         | 20 16 5     | 17.16-       |
| Mirach, in the thigh of Bootes                  | 3   | 14 36 10         | 2.63         | 27 56 27    | 15.67-       |
| Alphacca, the bright star in the Crown          | 2   | 15 26 4          | 2.54         | 27 24 39    | 12.60-       |
| Raf. Algethi, in the head of Hercules           | 2   | 17 25 27         | 2.74         | 14 38 1     | 4.87-        |
| Raf. Alhague, in the head of Ophiucus           | 2   | 17 5 22          | 2.75         | 12 43 18    | 3.15-        |
| Rafabab, in the head of the Dragon              | 2   | 17 51 53         | 1.37         | 51 30 59    | 0.78-        |
| Vega, the bright star in the Harp               | 1   | 18 30 1          | 2.02         | 38 35 54    | 2.52+        |
| Altair, the bright star in the Eagle            | 2   | 19 40 48         | 2.90         | 8 20 7      | 8.40+        |
| Deneb, in the tail of the Swan                  | 2   | 20 34 29         | 2.05         | 44 33 26    | 12.44+       |
| Aldebaran, in the shoulder of Cepheus           | 3   | 21 13 42         | 1.44         | 61 43 31    | 14.95+       |
| Scheat, in the thigh of Pegasus                 | 2   | 22 53 54         | 2.88         | 26 58 8     | 19.18+       |
| Marcab, in the wing of Pegasus                  | 2   | 22 54 37         | 2.98         | 14 6 37     | 19.20+       |
| Achernar, in the river Eridanus                 | 1   | 1 30 7           | 2.25         | 58 16 39 S. | 18.56-       |
| Rigel, in the foot of Orion                     | 1   | 5 4 44           | 2.89         | 8 26 52     | 4.94-        |
| Canopus, the bright star in Argo                | 1   | 6 19 26          | 1.34         | 52 35 23    | 1.60+        |
| Sirius, the bright star in the Great Dog        | 1   | 6 36 11          | 2.69         | 16 25 58    | 3.10+        |
| Alphard, in the heart of the female Hydra       | 2   | 9 17 34          | 2.96         | 7 46 53     | 15.13+       |
| Virgin's Spike, in the sheaf of Virgo           | 1   | 13 14 28         | 3.15         | 10 5 28     | 19.00+       |
| Zubenesh, in the south scale of Libra           | 2   | 14 39 38         | 3.31         | 15 11 3     | 15.50+       |
| Zubenelg, in the north scale of Libra           | 2   | 15 6 3           | 3.22         | 8 37 13     | 13.93+       |
| Antares, in the heart of Scorpio                | 1   | 16 16 56         | 3.66         | 25 57 55    | 8.90+        |
| Fomalhaut, bright star in the Southern Fish     | 1   | 22 46 20         | 3.33         | 30 41 52    | 18.97-       |
| The foot of the Cross                           | 1   | 12 15 24         | 3.22         | 61 57 50    | 20.01+       |
| The bright star in the Oars                     | 1   | 9 10 56          | 0.75         | 68 52 46    | 14.79+       |
| The bright star in Centaur                      | 1   | 14 26 12         | 4.41         | 59 59 37    | 16.26+       |

If the places of these stars are wanted for any time before the beginning of the year 1796, multiply the annual variation, both in right ascension and declination, by the number of years before 1796, and subtract the product from the right ascension standing in the table; but the product of the annual variation in declination must be added to, or subtracted from, the declination, according as the sign + or - follow it; but for any years after 1796, the variation in right ascension must be added to the right ascension in the table, and the variation in declination must be either added to, or subtracted from it, according as their signs are, to fit the declination to any succeeding year.—The annual variation is set down for seconds, and decimals of a second.



TABLE XXI. OF AMPLITUDES.

| Lat. | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 11   | 12   | 13   | 14   | 15   | 16   | 17   | 18   | 19   | 20   | 21   | 22   | 23   | 23-29 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
|      | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M. | D.M.  |
| 1    | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 2    | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 3    | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 4    | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 5    | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 6    | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 7    | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 8    | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 9    | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 10   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 11   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 12   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 13   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 14   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 15   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 16   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 17   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 18   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 19   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 20   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 21   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 22   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 23   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 24   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 25   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 26   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 27   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 28   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 29   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 30   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 31   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 32   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |
| 33   | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 23-29 |



TABLE XXI. OF AMPLITUDES.

DECLINATION IN DEGREES.

|      | 1    | 2    | 3    | 4    | 5     | 6     | 7     | 8     | 9     | 10    | 11    | 12    | 13    | 14    | 15    | 16    | 17    | 18    | 19    | 20    | 21    | 22    | 23    | 24    |
|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Lat. | D.M. | D.M. | D.M. | D.M. | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  | D.M.  |
| 34   | 1.12 | 2.25 | 3.37 | 4.50 | 6.2   | 7.15  | 8.27  | 9.39  | 10.52 | 12.5  | 13.18 | 14.31 | 15.44 | 16.57 | 18.11 | 19.25 | 20.39 | 21.53 | 23.7  | 24.21 | 25.36 | 26.51 | 28.7  | 28.44 |
| 35   | 1.13 | 2.27 | 3.40 | 4.53 | 6.6   | 7.20  | 8.33  | 9.47  | 11.0  | 12.14 | 13.28 | 14.42 | 15.55 | 17.11 | 18.25 | 19.40 | 20.55 | 22.10 | 23.25 | 24.40 | 25.56 | 27.13 | 28.29 | 29.7  |
| 36   | 1.14 | 2.28 | 3.43 | 4.57 | 6.11  | 7.25  | 8.39  | 9.54  | 11.1  | 12.23 | 13.38 | 14.53 | 16.9  | 17.24 | 18.39 | 19.55 | 21.11 | 22.27 | 23.43 | 25.0  | 26.18 | 27.35 | 28.53 | 29.30 |
| 37   | 1.15 | 2.30 | 3.45 | 5.0  | 6.15  | 7.31  | 8.46  | 10.2  | 11.17 | 12.33 | 13.49 | 15.5  | 16.21 | 17.38 | 18.54 | 20.11 | 21.28 | 22.46 | 24.3  | 25.21 | 26.39 | 27.58 | 29.17 | 29.56 |
| 38   | 1.16 | 2.32 | 3.48 | 5.5  | 6.21  | 7.37  | 8.54  | 10.11 | 11.27 | 12.44 | 14.1  | 15.18 | 16.35 | 17.53 | 19.10 | 20.28 | 21.46 | 23.5  | 24.24 | 25.43 | 27.3  | 28.23 | 29.43 | 30.23 |
| 39   | 1.17 | 2.34 | 3.51 | 5.8  | 6.26  | 7.43  | 9.1   | 10.19 | 11.37 | 12.54 | 14.12 | 15.31 | 16.49 | 18.8  | 19.27 | 20.46 | 22.6  | 23.26 | 24.46 | 26.6  | 27.27 | 28.49 | 30.11 | 30.51 |
| 40   | 1.18 | 2.36 | 3.55 | 5.13 | 6.32  | 7.50  | 9.17  | 10.28 | 11.47 | 13.6  | 14.25 | 15.45 | 17.5  | 18.24 | 19.44 | 21.5  | 22.26 | 23.47 | 25.9  | 26.31 | 27.53 | 29.16 | 30.40 | 31.22 |
| 41   | 1.19 | 2.39 | 3.58 | 5.18 | 6.38  | 7.57  | 9.17  | 10.37 | 11.57 | 13.18 | 14.39 | 16.0  | 17.21 | 18.42 | 20.4  | 21.26 | 22.48 | 24.10 | 25.33 | 26.56 | 28.21 | 29.46 | 31.11 | 31.53 |
| 42   | 1.21 | 2.41 | 4.2  | 5.23 | 6.44  | 8.5   | 9.26  | 10.47 | 12.9  | 13.31 | 14.53 | 16.15 | 17.37 | 19.0  | 20.23 | 21.46 | 23.10 | 24.34 | 25.58 | 27.24 | 28.50 | 30.16 | 31.43 | 32.26 |
| 43   | 1.22 | 2.44 | 4.6  | 5.28 | 6.51  | 8.13  | 9.35  | 10.58 | 12.21 | 13.44 | 15.7  | 16.31 | 17.55 | 19.19 | 20.43 | 22.8  | 24.34 | 25.59 | 26.35 | 27.53 | 29.20 | 30.48 | 32.16 | 33.0  |
| 44   | 1.23 | 2.47 | 4.10 | 5.34 | 6.58  | 8.21  | 9.45  | 11.9  | 12.34 | 13.58 | 15.23 | 16.48 | 18.13 | 19.39 | 21.5  | 22.32 | 23.59 | 25.26 | 26.54 | 28.23 | 29.53 | 31.22 | 32.51 | 33.37 |
| 45   | 1.25 | 2.50 | 4.15 | 5.40 | 7.5   | 8.30  | 9.56  | 11.2  | 12.47 | 14.13 | 15.38 | 17.6  | 18.33 | 20.0  | 21.28 | 22.56 | 24.25 | 25.54 | 27.23 | 28.56 | 30.27 | 31.58 | 33.30 | 34.16 |
| 46   | 1.26 | 2.53 | 4.19 | 5.46 | 7.12  | 8.39  | 10.6  | 11.34 | 13.1  | 14.28 | 15.56 | 17.25 | 18.54 | 20.23 | 21.52 | 23.23 | 24.53 | 26.25 | 27.58 | 29.31 | 31.3  | 32.37 | 34.12 | 35.0  |
| 47   | 1.28 | 2.56 | 4.24 | 5.52 | 7.20  | 8.49  | 10.18 | 11.47 | 13.16 | 14.44 | 16.15 | 17.45 | 19.16 | 20.47 | 22.18 | 23.50 | 25.23 | 26.57 | 28.32 | 30.7  | 31.42 | 33.18 | 34.56 | 35.77 |
| 48   | 1.29 | 2.59 | 4.29 | 5.59 | 7.29  | 8.59  | 10.30 | 12.0  | 13.31 | 15.2  | 16.34 | 18.6  | 19.39 | 21.12 | 22.45 | 24.40 | 25.55 | 27.31 | 29.7  | 30.45 | 32.23 | 34.3  | 35.42 | 36.35 |
| 49   | 1.31 | 3.3  | 4.34 | 6.6  | 7.38  | 9.10  | 10.42 | 12.14 | 13.47 | 15.21 | 16.54 | 18.28 | 20.3  | 21.38 | 23.14 | 24.51 | 26.28 | 28.8  | 29.45 | 31.25 | 33.6  | 34.48 | 36.33 | 37.26 |
| 50   | 1.33 | 3.6  | 4.40 | 6.14 | 7.48  | 9.21  | 10.55 | 12.46 | 14.5  | 15.40 | 17.16 | 18.52 | 20.29 | 22.6  | 23.45 | 25.24 | 27.3  | 28.43 | 30.25 | 32.8  | 33.52 | 35.37 | 37.26 | 38.20 |
| 51   | 1.35 | 3.10 | 4.46 | 6.22 | 7.58  | 9.33  | 11.9  | 12.46 | 14.24 | 16.1  | 17.39 | 19.18 | 20.57 | 22.37 | 24.18 | 25.59 | 27.41 | 29.24 | 31.8  | 32.54 | 34.41 | 36.30 | 38.23 | 39.19 |
| 52   | 1.37 | 3.15 | 4.52 | 6.30 | 8.8   | 9.46  | 11.24 | 13.3  | 14.43 | 16.23 | 18.6  | 19.44 | 21.26 | 23.8  | 24.52 | 26.36 | 28.21 | 30.7  | 31.55 | 33.44 | 35.34 | 37.27 | 39.24 | 40.23 |
| 53   | 1.40 | 3.20 | 4.59 | 6.39 | 8.19  | 10.0  | 11.40 | 13.21 | 15.3  | 16.46 | 18.29 | 20.12 | 21.57 | 23.42 | 25.28 | 27.16 | 29.0  | 30.53 | 32.45 | 34.38 | 36.33 | 38.29 | 40.29 | 41.29 |
| 54   | 1.42 | 3.24 | 5.5  | 6.49 | 8.31  | 10.15 | 11.57 | 13.41 | 15.26 | 17.11 | 18.57 | 20.43 | 22.30 | 24.18 | 26.7  | 27.58 | 29.50 | 31.42 | 33.38 | 35.35 | 37.32 | 39.26 | 41.43 | 42.40 |
| 55   | 1.45 | 3.29 | 5.14 | 6.59 | 8.44  | 10.30 | 12.15 | 14.2  | 15.49 | 17.37 | 19.26 | 21.14 | 23.5  | 24.56 | 26.49 | 28.43 | 30.39 | 32.35 | 34.35 | 36.36 | 38.39 | 40.47 | 42.56 | 44.0  |
| 56   | 1.47 | 3.34 | 5.22 | 7.10 | 8.57  | 10.47 | 12.35 | 14.24 | 16.14 | 18.5  | 19.56 | 21.49 | 23.43 | 25.37 | 27.32 | 29.32 | 31.31 | 33.33 | 35.36 | 37.42 | 39.51 | 42.4  | 44.19 | 45.27 |
| 57   | 1.50 | 3.40 | 5.31 | 7.22 | 9.11  | 11.4  | 12.56 | 14.48 | 16.45 | 18.33 | 20.29 | 22.25 | 24.23 | 26.21 | 28.22 | 30.24 | 32.24 | 34.34 | 36.46 | 38.53 | 41.9  | 43.27 | 45.50 | 47.2  |
| 58   | 1.53 | 3.46 | 5.40 | 7.34 | 9.26  | 11.22 | 13.18 | 15.14 | 17.10 | 19.7  | 21.4  | 23.4  | 25.0  | 27.9  | 29.14 | 31.1  | 33.28 | 35.40 | 37.54 | 40.12 | 42.34 | 44.59 | 47.30 | 48.46 |
| 59   | 1.56 | 3.53 | 5.50 | 7.47 | 9.43  | 11.42 | 13.41 | 15.41 | 17.4  | 19.41 | 21.43 | 23.47 | 25.42 | 27.48 | 29.41 | 31.2  | 32.34 | 34.12 | 36.53 | 39.13 | 41.37 | 43.46 | 45.49 | 47.51 |
| 60   | 2.0  | 4.0  | 6.0  | 8.1  | 10.2  | 12.4  | 14.6  | 16.10 | 18.14 | 20.18 | 22.26 | 24.34 | 26.46 | 28.55 | 31.9  | 33.27 | 35.47 | 38.9  | 40.16 | 43.10 | 45.48 | 48.31 | 51.24 | 52.51 |
| 61   | 2.3  | 4.8  | 6.12 | 8.17 | 10.21 | 12.27 | 14.34 | 16.40 | 18.49 | 20.57 | 23.10 | 25.23 | 27.39 | 29.56 | 32.16 | 34.39 | 37.5  | 39.36 | 42.11 | 44.52 | 47.40 | 50.35 | 53.48 | 55.17 |
| 62   | 2.7  | 4.15 | 6.24 | 8.32 | 10.41 | 12.52 | 15.2  | 17.14 | 19.28 | 21.42 | 23.59 | 25.17 | 28.37 | 31.1  | 33.27 | 35.57 | 38.31 | 41.10 | 43.54 | 46.46 | 49.46 | 52.56 | 56.20 | 58.4  |
| 63   | 2.12 | 4.24 | 6.37 | 8.50 | 11.4  | 13.19 | 15.34 | 17.51 | 20.9  | 22.27 | 24.51 | 27.15 | 29.42 | 32.12 | 34.45 | 37.23 | 40.5  | 42.54 | 45.49 | 48.52 | 51.55 | 54.61 | 57.24 | 61.23 |
| 64   | 2.17 | 4.33 | 6.51 | 9.9  | 11.28 | 13.47 | 16.8  | 19.30 | 22.54 | 25.18 | 27.48 | 29.30 | 31.1  | 32.57 | 34.41 | 36.21 | 38.57 | 41.49 | 44.49 | 47.57 | 51.7  | 54.50 | 58.43 | 63.63 |
| 65   | 2.22 | 4.44 | 7.0  | 9.30 | 11.54 | 14.19 | 16.45 | 19.13 | 21.43 | 23.13 | 25.46 | 27.28 | 29.34 | 31.55 | 33.46 | 35.46 | 37.46 | 40.44 | 43.46 | 46.50 | 49.54 | 52.59 | 56.67 | 60.73 |
| 66   | 2.27 | 4.55 | 7.23 | 9.25 | 12.21 | 14.53 | 17.20 | 20.0  | 22.37 | 24.13 | 26.44 | 28.24 | 30.24 | 32.24 | 34.24 | 36.24 | 38.24 | 40.24 | 42.24 | 44.24 | 46.24 | 48.24 | 50.24 | 52.24 |

A TABLE shewing the Time of the Sun, Moon, and Stars' Setting, when they have North Declination, or the Time of their Rising, when they have South Declination.

A TABLE shewing the Time of the Sun, Moon, and Stars' Setting, when they have North Declination, or the Time of their Rising, when they have South Declination.

## DEGREES OF DECLINATION.

[illegible]



TABLE XXII.

A TABLE shewing the Time of the Sun, Moon, and Stars' Setting, when they have North Declination, or the Time of their Rising, when they have South Declination

| D E G R E E S O F D E C L I N A T I O N. |   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |     |
|------------------------------------------|---|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----|
| Lat.                                     | 0 | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 11   | 12   | 13   | 14   | 15   | 16   | 17   | 18   | 19   | 20   | 21   | 22   | 23   | 2339 | Lat. |      |     |
| 31°                                      | H | M    | 6.00 | 6.02 | 6.05 | 6.07 | 6.10 | 6.12 | 6.15 | 6.17 | 6.19 | 6.22 | 6.24 | 6.27 | 6.29 | 6.32 | 6.34 | 6.37 | 6.40 | 6.42 | 6.45 | 6.48 | 6.51 | 6.53 | 6.56 | 6.59 | 7.01 | 31° |
| 32                                       | M | 6.00 | 6.01 | 6.03 | 6.05 | 6.08 | 6.10 | 6.13 | 6.15 | 6.18 | 6.20 | 6.23 | 6.25 | 6.28 | 6.31 | 6.33 | 6.36 | 6.39 | 6.41 | 6.44 | 6.47 | 6.50 | 6.53 | 6.56 | 6.58 | 7.01 | 7.03 | 32  |
| 33                                       | H | 6.00 | 6.01 | 6.03 | 6.06 | 6.08 | 6.10 | 6.13 | 6.16 | 6.18 | 6.21 | 6.24 | 6.26 | 6.29 | 6.32 | 6.34 | 6.37 | 6.40 | 6.43 | 6.46 | 6.49 | 6.52 | 6.55 | 6.58 | 7.01 | 7.04 | 7.06 | 33  |
| 34                                       | M | 6.00 | 6.03 | 6.05 | 6.08 | 6.11 | 6.14 | 6.16 | 6.19 | 6.22 | 6.25 | 6.27 | 6.30 | 6.33 | 6.36 | 6.39 | 6.42 | 6.45 | 6.48 | 6.51 | 6.54 | 6.57 | 6.59 | 7.02 | 7.06 | 7.08 | 34   |     |
| 35                                       | H | 6.00 | 6.03 | 6.06 | 6.08 | 6.11 | 6.14 | 6.17 | 6.20 | 6.23 | 6.25 | 6.28 | 6.31 | 6.34 | 6.37 | 6.40 | 6.43 | 6.46 | 6.49 | 6.53 | 6.56 | 6.59 | 7.02 | 7.06 | 7.09 | 7.11 | 35   |     |
| 36                                       | M | 6.00 | 6.03 | 6.06 | 6.09 | 6.12 | 6.15 | 6.18 | 6.20 | 6.23 | 6.26 | 6.29 | 6.32 | 6.36 | 6.39 | 6.42 | 6.45 | 6.48 | 6.51 | 6.55 | 6.58 | 7.01 | 7.04 | 7.08 | 7.12 | 7.14 | 36   |     |
| 37                                       | H | 6.00 | 6.03 | 6.06 | 6.09 | 6.12 | 6.15 | 6.18 | 6.21 | 6.24 | 6.27 | 6.31 | 6.34 | 6.37 | 6.40 | 6.43 | 6.47 | 6.50 | 6.53 | 6.57 | 7.00 | 7.04 | 7.07 | 7.11 | 7.15 | 7.17 | 37   |     |
| 38                                       | M | 6.00 | 6.03 | 6.06 | 6.09 | 6.13 | 6.16 | 6.19 | 6.22 | 6.25 | 6.28 | 6.32 | 6.35 | 6.38 | 6.42 | 6.45 | 6.48 | 6.52 | 6.55 | 6.59 | 7.02 | 7.06 | 7.10 | 7.14 | 7.17 | 7.19 | 38   |     |
| 39                                       | H | 6.00 | 6.03 | 6.06 | 6.10 | 6.13 | 6.16 | 6.20 | 6.23 | 6.26 | 6.29 | 6.33 | 6.36 | 6.40 | 6.43 | 6.47 | 6.50 | 6.54 | 6.57 | 7.01 | 7.05 | 7.09 | 7.12 | 7.16 | 7.20 | 7.22 | 39   |     |
| 40                                       | M | 6.00 | 6.03 | 6.07 | 6.10 | 6.13 | 6.17 | 6.20 | 6.24 | 6.27 | 6.31 | 6.34 | 6.38 | 6.41 | 6.45 | 6.48 | 6.52 | 6.56 | 7.00 | 7.03 | 7.07 | 7.11 | 7.15 | 7.19 | 7.23 | 7.25 | 40   |     |
| 41                                       | H | 6.00 | 6.03 | 6.07 | 6.10 | 6.14 | 6.17 | 6.21 | 6.25 | 6.28 | 6.32 | 6.35 | 6.39 | 6.43 | 6.46 | 6.50 | 6.54 | 6.58 | 7.02 | 7.06 | 7.10 | 7.14 | 7.18 | 7.22 | 7.27 | 7.29 | 41   |     |
| 42                                       | M | 6.00 | 6.04 | 6.07 | 6.11 | 6.14 | 6.18 | 6.22 | 6.25 | 6.29 | 6.33 | 6.37 | 6.40 | 6.44 | 6.48 | 6.52 | 6.56 | 7.00 | 7.04 | 7.08 | 7.12 | 7.17 | 7.21 | 7.25 | 7.30 | 7.32 | 42   |     |
| 43                                       | H | 6.00 | 6.04 | 6.07 | 6.11 | 6.15 | 6.19 | 6.23 | 6.26 | 6.30 | 6.34 | 6.38 | 6.42 | 6.46 | 6.50 | 6.54 | 6.58 | 7.02 | 7.06 | 7.11 | 7.15 | 7.19 | 7.24 | 7.28 | 7.33 | 7.36 | 43   |     |
| 44                                       | M | 6.00 | 6.04 | 6.08 | 6.12 | 6.15 | 6.19 | 6.23 | 6.27 | 6.31 | 6.35 | 6.39 | 6.43 | 6.47 | 6.52 | 6.56 | 7.00 | 7.04 | 7.09 | 7.13 | 7.18 | 7.22 | 7.27 | 7.31 | 7.36 | 7.39 | 44   |     |
| 45                                       | H | 6.00 | 6.04 | 6.08 | 6.12 | 6.16 | 6.20 | 6.24 | 6.28 | 6.32 | 6.36 | 6.41 | 6.45 | 6.49 | 6.53 | 6.58 | 7.02 | 7.07 | 7.11 | 7.16 | 7.21 | 7.25 | 7.30 | 7.35 | 7.40 | 7.43 | 45   |     |
| 46                                       | M | 6.00 | 6.04 | 6.08 | 6.12 | 6.17 | 6.21 | 6.25 | 6.29 | 6.33 | 6.38 | 6.42 | 6.46 | 6.51 | 6.55 | 7.00 | 7.04 | 7.09 | 7.14 | 7.19 | 7.24 | 7.29 | 7.34 | 7.39 | 7.44 | 7.47 | 46   |     |
| 47                                       | H | 6.00 | 6.04 | 6.09 | 6.13 | 6.17 | 6.22 | 6.26 | 6.30 | 6.35 | 6.39 | 6.43 | 6.48 | 6.53 | 6.57 | 7.02 | 7.07 | 7.12 | 7.17 | 7.22 | 7.27 | 7.32 | 7.37 | 7.43 | 7.48 | 7.51 | 47   |     |
| 48                                       | M | 6.00 | 6.04 | 6.09 | 6.13 | 6.18 | 6.22 | 6.27 | 6.31 | 6.36 | 6.41 | 6.45 | 6.50 | 6.55 | 6.59 | 7.04 | 7.09 | 7.14 | 7.19 | 7.25 | 7.30 | 7.35 | 7.41 | 7.47 | 7.53 | 7.56 | 48   |     |
| 49                                       | H | 6.00 | 6.05 | 6.09 | 6.14 | 6.18 | 6.23 | 6.27 | 6.32 | 6.37 | 6.42 | 6.47 | 6.52 | 6.57 | 7.02 | 7.07 | 7.12 | 7.17 | 7.22 | 7.28 | 7.33 | 7.39 | 7.45 | 7.51 | 7.57 | 8.00 | 49   |     |
| 50                                       | M | 6.00 | 6.05 | 6.10 | 6.14 | 6.19 | 6.24 | 6.29 | 6.34 | 6.39 | 6.44 | 6.49 | 6.54 | 6.59 | 7.04 | 7.09 | 7.14 | 7.20 | 7.25 | 7.31 | 7.37 | 7.43 | 7.49 | 7.55 | 8.02 | 8.05 | 50   |     |
| 51                                       | H | 6.00 | 6.05 | 6.10 | 6.15 | 6.20 | 6.25 | 6.30 | 6.35 | 6.40 | 6.45 | 6.50 | 6.56 | 7.01 | 7.06 | 7.12 | 7.17 | 7.23 | 7.29 | 7.35 | 7.41 | 7.47 | 7.53 | 8.00 | 8.06 | 8.10 | 51   |     |
| 52                                       | M | 6.00 | 6.05 | 6.10 | 6.15 | 6.21 | 6.26 | 6.31 | 6.36 | 6.41 | 6.47 | 6.52 | 6.58 | 7.03 | 7.09 | 7.14 | 7.20 | 7.26 | 7.32 | 7.38 | 7.45 | 7.51 | 7.58 | 8.05 | 8.12 | 8.16 | 52   |     |
| 53                                       | H | 6.00 | 6.05 | 6.11 | 6.16 | 6.22 | 6.27 | 6.32 | 6.38 | 6.43 | 6.49 | 6.54 | 7.00 | 7.06 | 7.11 | 7.17 | 7.23 | 7.29 | 7.36 | 7.42 | 7.49 | 7.56 | 8.03 | 8.10 | 8.17 | 8.21 | 53   |     |
| 54                                       | M | 6.00 | 6.06 | 6.11 | 6.17 | 6.22 | 6.28 | 6.33 | 6.39 | 6.45 | 6.50 | 6.56 | 7.02 | 7.08 | 7.14 | 7.20 | 7.27 | 7.33 | 7.40 | 7.46 | 7.53 | 8.00 | 8.08 | 8.15 | 8.23 | 8.27 | 54   |     |
| 55                                       | H | 6.00 | 6.06 | 6.11 | 6.17 | 6.23 | 6.29 | 6.35 | 6.40 | 6.46 | 6.52 | 6.58 | 7.04 | 7.11 | 7.17 | 7.23 | 7.30 | 7.37 | 7.44 | 7.51 | 7.58 | 8.05 | 8.13 | 8.21 | 8.29 | 8.33 | 55   |     |
| 56                                       | M | 6.00 | 6.06 | 6.12 | 6.18 | 6.24 | 6.30 | 6.36 | 6.42 | 6.48 | 6.54 | 7.00 | 7.07 | 7.13 | 7.20 | 7.27 | 7.34 | 7.41 | 7.48 | 7.55 | 8.03 | 8.11 | 8.19 | 8.27 | 8.36 | 8.40 | 56   |     |
| 57                                       | H | 6.00 | 6.06 | 6.12 | 6.19 | 6.25 | 6.31 | 6.37 | 6.44 | 6.50 | 6.56 | 7.03 | 7.10 | 7.16 | 7.23 | 7.30 | 7.38 | 7.45 | 7.52 | 8.00 | 8.08 | 8.16 | 8.25 | 8.34 | 8.43 | 8.48 | 57   |     |
| 58                                       | M | 6.00 | 6.06 | 6.13 | 6.19 | 6.26 | 6.32 | 6.39 | 6.45 | 6.52 | 6.58 | 7.06 | 7.13 | 7.20 | 7.27 | 7.34 | 7.42 | 7.49 | 7.57 | 8.05 | 8.14 | 8.23 | 8.32 | 8.41 | 8.51 | 8.56 | 58   |     |
| 59                                       | H | 6.00 | 6.07 | 6.13 | 6.20 | 6.27 | 6.33 | 6.40 | 6.47 | 6.54 | 7.01 | 7.08 | 7.16 | 7.23 | 7.30 | 7.38 | 7.46 | 7.54 | 8.03 | 8.11 | 8.20 | 8.29 | 8.38 | 8.49 | 9.00 | 9.05 | 59   |     |
| 60                                       | M | 6.00 | 6.07 | 6.14 | 6.21 | 6.28 | 6.35 | 6.42 | 6.49 | 6.56 | 7.03 | 7.11 | 7.19 | 7.26 | 7.34 | 7.42 | 7.51 | 7.59 | 8.08 | 8.17 | 8.26 | 8.36 | 8.47 | 8.58 | 9.09 | 9.16 | 60   |     |



## To find the Time of the Sun's Rising, Setting, and Length of the Day and Night, by this Table.

First. Find the sun's declination at the top of the page (marked with the degrees of declination) and the latitude in the right or left hand columns (marked lat.) and in the common angle of meeting is the time of sun setting, if the sun has north declination, but the time of sun rising, if the sun has south declination.

### E X A M P L E I.

Let it be required to find the time of the sun's rising and setting, with the length of the day and night, in latitude  $51^{\circ}$  north, the 18th of July, 1796?

I first seek the sun's declination for the given day, and find it  $20^{\circ} 53'$  north, which I here call  $21^{\circ}$ , then under the declination 21, and against the latitude  $51^{\circ}$ , stands 7 hours 53 minutes, the time the sun sets on the given day, in lat.  $51^{\circ}$  north, which being doubled, gives 15 hours 46 minutes, the length of the day; and if 7 hours 53 minutes, the time of sun-setting, be subtracted from 12 hours, the remainder 4 hours 7 minutes, gives the time of the sun's rising, which being doubled, gives 8 hours 14 minutes, length of the night.

But, when the sun has  $21^{\circ}$  south declination in this latitude, the time of sun-setting becomes the time of sun-rising, and the length of the day will then become the length of the night.

Thus, the 25th of November, 1796, the sun's declination is  $20^{\circ} 59'$  south, or  $21^{\circ}$ , then the time of sun-rising is 7 hours 53 minutes, his setting 4 hours 7 minutes, and the length of the night 15 hours 46 minutes, and day 8 hours 14 minutes.

### E X A M P L E II.

Let it be required to find the time of the sun's rising, setting, and length of the day and night, at Petersburg, the 21st of June, 1796.

Under  $23^{\circ} 28' N.$  the declination that day, and against  $60^{\circ}$  north, the latitude of Petersburg,

Stands the sun's setting

12 0  
9 16

The time of sun-rising

2 44

Sun-setting doubled is the length of day 18 32

Sun-rising doubled is the length of night 5 28

When a greater degree of accuracy is required, proportional parts may be taken for degrees and minutes of latitude and declination.

### E X A M P L E III.

Required the time of the sun's rising and setting, and length of the day, at the Cape of Good Hope, in lat.  $34.29 S.$  the 13th of May, 1796.

Under the declination  $19^{\circ} 6'$  or  $19^{\circ} N.$  and against the lat.  $34 S.$

Stands the sun's rising

12 0  
6 54

Time of sun's setting

5 6

The length of the day

2

And 6H. 54M. doub. is length of night 13 48

## To find the Rising and Setting of the Stars.

By this table the rising and setting of any star may be found, whose declination does not exceed  $23^{\circ} 30'$  north or south, in the following manner:

If you are in north latitude, and the star has north declination, look for the declination at the top, and the latitude in the right or left hand columns, in the angle of meeting, is half the time of the star's continuance above the horizon, in that latitude; or the time it takes in ascending from the eastern side of the horizon to the meridian, and descending from the meridian to the western part of the horizon.

Therefore, if these hours and minutes be subtracted from the time of the star's coming to the meridian, the remainder will be the time of the star's rising, and if added, the sum will be the time of the star's setting.

### E X A M P L E I.

Required when the star Arcturus rises and sets December 1, in lat.  $51^{\circ} N.$

The time of the star's coming to the meridian, or southing in the morning

9 35

Then under star's declination  $20^{\circ} 16'$  or  $20^{\circ} N.$  and against lat.  $51$  stands

7 47

Time of star's rising in the morning

1 48

Added, gives the time of the star's setting

17 22

12

Star sets 22 minutes after 5 in the evening

5 22

When the latitude is north, and the star has south declination, or the latitude south and the star has north declination, find the latitude in the side columns as before, against which, and under the degrees of declination, stands half the time the star is under the horizon, which being subtracted from 12, the remainder will be half the time the star will be above the horizon in that latitude.

Example. What time will the Dog Star, Sirius, rise and set at London, Jan. 25?

|                                                                                                    |       |  |
|----------------------------------------------------------------------------------------------------|-------|--|
| Under the declination $16^{\circ} 26' S.$ and against lat. $51^{\circ} 32'$ or $52^{\circ}$ stands | 12 0  |  |
|                                                                                                    | 7 26  |  |
| Half the time the star is above the horizon                                                        | 4 34  |  |
| The star comes to the meridian in the evening, at                                                  | 10 05 |  |
| Which subtracted, shews that the star rises at 31 M after 5 in the evening                         | 5 31  |  |
| Added, shews the time the star sets in the morning                                                 | 2 39  |  |

In like manner may the rising and setting of the planets be found when their declination does not exceed  $23^{\circ} \frac{1}{2}$ , and the time of their passage over the meridian is known.

Suppose it were required to know the time of Jupiter's rising and setting, in latitude  $52^{\circ}$  north, the 1st of August, 1796.

In the Nautical Almanack for 1796, I find that Jupiter passes over the meridian of Greenwich at 14 H. 3 M. that is 3 minutes after 2 next morning, and his declination is  $8^{\circ} 27' S.$

Now, 12 H. added to 14 H. 3 M. is 26 H. 3 M. from which subtract 24 H. and the remainder 2 H. 3 M. is the time of his passing the meridian in the morning of that day, according to the civil account.

Under declination  $8^{\circ} 27'$  or  $8^{\circ}$  and against latitude  $52^{\circ}$  stand 6 H. 41 M. half the time Jupiter is below the horizon, this doubled is 13 H. 22 M. the length of Jupiter's night, which subtracted from 24 H. gives 10 H. 38 M. the length of his day.

Again, 6 H. 41 M. added to his passing the meridian 2 H. 3 M. gives 8 H. 44 M. his rising in the evening, and 2 H. 3 M. added to 12 H. gives 14 H. 3 M. from this sum take 6 H. 41 M. and the remainder 7 H. 22 M. is the time of his setting in the morning.

Suppose it were required to find the moon's rising and setting August the 13th, 1796 in latitude  $52^{\circ}$  north.

In the Nautical Almanac, (page 6th) I find that the moon passes the meridian of Greenwich at 8 H. 16 M. in the evening, and her declination at midnight is  $22^{\circ} 55' S.$

Then in the tables, under the declination  $21^{\circ} 32' S.$  or  $22^{\circ}$ , and against the lat.  $52^{\circ}$  stands 8 H. 5 M. Half the time she is under the horizon doubled is 16 H. 10 M. the length of the lunar night, which subtracted from 24 H. leaves 7 H. 50 M. the lunar day. To the moon's southing or passage over the meridian, 8 H. 16 M. add half the lunar day 3 H. 35 M. gives 11 H. 51 M. her setting at midnight, and from 8 H. 16 M. take 3, 35, the remainder 4 H. 41 M. is the time of her rising in the afternoon.

In like manner may be found the rising and setting of the other planets, only observing, that the noon of the common day, and end of the sea day, is the beginning of the day in the Nautical Almanac.

As all the calculations here are made for the meridian of London, or Greenwich, care must be taken to reduce the time of their passages over the meridian of Greenwich, to the meridian of the place of observation, by allowing 1 H. later for every  $15^{\circ}$  of west longitude, and 1 H. sooner for every  $15^{\circ}$  of east longitude.

It were to be wished, that gentlemen belonging to the sea would carry a celestial globe with them, upon which all the above may be found in an easy manner; for they would have nothing more to do but to set the globe north and south, raise the pole as many degrees above the horizon as the latitude is; bring the sun's place to the brazen meridian, and set the index to the upper 12, then turn the globe round, and note what stars come to the meridian, and the hour index will point to the time; when they come above the horizon, it will point to the time of their rising, and when they descend below the horizon it will point to their setting, for as each star on the globe will point directly to one of the same name in the heavens, they may be viewed at any time of the night; or, if a planet, turn the globe until the index points to the time of their passage over the meridian, and make a mark on the globe with a pencil under their declination, then turn the globe east until the mark comes to the horizon, and the index will point to the time of their rising; and turned westerly till it come to the horizon, the index will point to the time of their setting.

TABLE XXIII. FOR FINDING THE DISTANCE OF TERRESTRIAL  
OBJECTS AT SEA.

| Height<br>in Feet | Dist. in<br>Miles | Height<br>in Feet | Dist. in<br>Miles | Height<br>in Feet | Dist. in<br>Miles | Height<br>in Feet | Dist. in<br>Miles | Height<br>in Feet | Dist. in<br>Miles |
|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| 1                 | 1.224             | 53                | 8.914             | 240               | 18.969            | 760               | 33.756            | 2250              | 58.083            |
| 2                 | 1.732             | 56                | 9.163             | 245               | 19.165            | 780               | 34.197            | 2300              | 58.725            |
| 3                 | 2.121             | 59                | 9.405             | 250               | 19.360            | 800               | 34.633            | 2350              | 59.360            |
| 4                 | 2.449             | 62                | 9.641             | 255               | 19.553            | 820               | 35.063            | 2400              | 59.988            |
| 5                 | 2.738             | 65                | 9.870             | 260               | 19.743            | 840               | 35.488            | 2450              | 60.609            |
| 6                 | 2.999             | 68                | 10.097            | 265               | 19.932            | 860               | 35.908            | 2500              | 61.225            |
| 7                 | 3.239             | 71                | 10.317            | 270               | 20.119            | 880               | 36.323            | 2550              | 61.834            |
| 8                 | 3.463             | 74                | 10.533            | 275               | 20.305            | 900               | 36.734            | 2600              | 62.437            |
| 9                 | 3.673             | 77                | 10.745            | 280               | 20.489            | 920               | 37.140            | 2650              | 63.035            |
| 10                | 3.872             | 80                | 10.952            | 285               | 20.671            | 940               | 37.546            | 2700              | 63.626            |
| 11                | 4.061             | 83                | 11.156            | 290               | 20.851            | 960               | 37.938            | 2750              | 64.213            |
| 12                | 4.242             | 86                | 11.355            | 295               | 21.030            | 980               | 38.332            | 2800              | 64.794            |
| 13                | 4.415             | 89                | 11.552            | 300               | 21.208            | 1000              | 38.721            | 2850              | 65.370            |
| 14                | 4.581             | 92                | 11.745            | 310               | 21.558            | 1030              | 39.297            | 2900              | 65.940            |
| 15                | 4.742             | 95                | 11.932            | 320               | 21.903            | 1060              | 39.866            | 2950              | 66.507            |
| 16                | 4.898             | 98                | 12.121            | 330               | 22.243            | 1090              | 40.426            | 3000              | 67.068            |
| 17                | 5.048             | 101               | 12.306            | 340               | 22.578            | 1120              | 40.978            | 3050              | 67.625            |
| 18                | 5.195             | 104               | 12.487            | 350               | 22.907            | 1150              | 41.524            | 3100              | 68.177            |
| 19                | 5.338             | 107               | 12.666            | 360               | 23.232            | 1180              | 42.062            | 3150              | 68.725            |
| 20                | 5.476             | 110               | 12.842            | 370               | 23.553            | 1210              | 42.593            | 3200              | 69.268            |
| 21                | 5.611             | 113               | 13.016            | 380               | 23.869            | 1240              | 43.118            | 3250              | 69.807            |
| 22                | 5.743             | 116               | 13.188            | 390               | 24.181            | 1270              | 43.636            | 3300              | 70.342            |
| 23                | 5.872             | 119               | 13.357            | 400               | 24.489            | 1300              | 44.149            | 3350              | 70.873            |
| 24                | 5.999             | 122               | 13.525            | 410               | 24.793            | 1330              | 44.659            | 3400              | 71.400            |
| 25                | 6.122             | 125               | 13.690            | 420               | 25.094            | 1360              | 45.156            | 3450              | 71.923            |
| 26                | 6.243             | 128               | 13.853            | 430               | 25.391            | 1390              | 45.651            | 3500              | 72.443            |
| 27                | 6.362             | 131               | 14.015            | 440               | 25.684            | 1420              | 46.140            | 3550              | 72.958            |
| 28                | 6.479             | 134               | 14.174            | 450               | 25.974            | 1450              | 46.629            | 3600              | 73.470            |
| 29                | 6.594             | 137               | 14.332            | 460               | 26.261            | 1480              | 47.106            | 3650              | 73.979            |
| 30                | 6.709             | 140               | 14.488            | 470               | 26.545            | 1510              | 47.581            | 3700              | 74.484            |
| 31                | 6.817             | 143               | 14.642            | 480               | 26.826            | 1540              | 48.052            | 3750              | 74.985            |
| 32                | 6.928             | 146               | 14.795            | 490               | 27.104            | 1570              | 48.517            | 3800              | 75.484            |
| 33                | 7.034             | 150               | 14.995            | 500               | 27.379            | 1600              | 48.979            | 3850              | 75.979            |
| 34                | 7.140             | 155               | 15.244            | 510               | 27.652            | 1630              | 49.436            | 3900              | 76.471            |
| 35                | 7.244             | 160               | 15.488            | 520               | 27.922            | 1660              | 49.889            | 3950              | 76.959            |
| 36                | 7.347             | 165               | 15.728            | 530               | 28.189            | 1690              | 50.338            | 4000              | 77.445            |
| 37                | 7.448             | 170               | 15.965            | 540               | 28.454            | 1720              | 50.782            | 4050              | 77.927            |
| 38                | 7.548             | 175               | 16.198            | 550               | 28.716            | 1750              | 51.223            | 4100              | 78.407            |
| 39                | 7.647             | 180               | 16.427            | 560               | 28.976            | 1780              | 51.661            | 4150              | 78.884            |
| 40                | 7.744             | 185               | 16.654            | 570               | 28.233            | 1810              | 52.094            | 4200              | 79.358            |
| 41                | 7.840             | 190               | 16.878            | 580               | 29.489            | 1840              | 52.524            | 4250              | 79.829            |
| 42                | 7.935             | 195               | 17.098            | 590               | 29.742            | 1870              | 52.951            | 4300              | 80.297            |
| 43                | 8.029             | 200               | 17.316            | 600               | 29.994            | 1900              | 53.374            | 4350              | 80.662            |
| 44                | 8.122             | 205               | 17.531            | 620               | 30.489            | 1930              | 53.793            | 4400              | 81.215            |
| 45                | 8.214             | 210               | 17.748            | 640               | 30.976            | 1960              | 54.219            | 4450              | 81.685            |
| 46                | 8.305             | 215               | 17.955            | 660               | 31.457            | 2000              | 54.761            | 4500              | 82.143            |
| 47                | 8.394             | 220               | 18.160            | 680               | 31.930            | 2050              | 55.441            | 4550              | 82.598            |
| 48                | 8.483             | 225               | 18.366            | 700               | 32.396            | 2100              | 56.113            | 4600              | 83.051            |
| 49                | 8.570             | 230               | 18.569            | 720               | 32.855            | 2150              | 56.777            | 4650              | 83.501            |
| 50                | 8.658             | 235               | 18.770            | 740               | 33.309            | 2200              | 57.434            | 4700              | 83.919            |



TABLE XXIV.

## OF THE LATITUDES AND LONGITUDES

OF THE

## PRINCIPAL HARBOURS AND CAPES IN THE WORLD;

With the TIMES of HIGH WATER where it is known.—The Longitude is reckoned from the Meridian of London.—Places marked thus \*, are by Celestial Observations, others not so marked, are from the best Charts and Maps.

*The Coast of England, from London to the Land's End.*

|                           | Lat.<br>D. M. | Long.<br>D. M. | H. W.<br>H. |
|---------------------------|---------------|----------------|-------------|
| * LONDON                  | 51 32N.       | 0 0            |             |
| * Green. Obsf.            | 51 29         | 0 5 E.         |             |
| Woolwich                  | 51 30         | 0 9            |             |
| Purfleet                  | 51 30         | 0 19           |             |
| Gravesend                 | 51 27         | 0 28           |             |
| Rochester                 | 51 23         | 0 38           |             |
| Nore                      | 51 28         | 0 51           |             |
| S. Foreland lights        | 51 12         | 1 30           |             |
| * Dover                   | 51 8          | 1 24           | 11          |
| Dungeness                 | 50 52         | 1 5            | 10          |
| Hastings                  | 50 53         | 0 47           | 10          |
| Beachy Head               | 50 44         | 0 26           | 10          |
| Shoreham                  | 50 47         | 0 11 W         | 9           |
| Arundel                   | 50 46         | 0 26           | 9           |
| Selfey Bill               | 50 43         | 0 41           | 9           |
| Owers, S. E. Part         | 50 36         | 0 36           | 9           |
| * Portsmouth              |               |                |             |
| Town                      | 50 47         | 1 0            | 11          |
| Isle of Wight.            |               |                |             |
| * Bembridge               |               |                |             |
| Ledge or Point            | 50 40         | 0 59           | 11          |
| * Dunnose                 | 50 33         | 1 10           | 9           |
| * Saint Catherine's Point | 50 30         | 1 14           | 9           |
| * Needles Lts.            | 50 41         | 1 24           | 9           |
| Pool Harbour              | 50 42         | 2 5            | 9           |
| St. Alban's Head          | 50 37         | 2 8            | 7           |
| * Weymouth                | 50 37         | 2 30           | 6           |
| Portland Lights           | 50 31         | 2 31           | 7           |
| Exmouth Bar               | 50 37         | 3 18           | 6           |
| Torbay, Berry Head        | 50 22         | 3 22           | 6           |
| Dartmouth                 | 50 18         | 3 33           | 6           |
| * Start Point             | 50 9          | 3 40           | 6           |
| Praul ditto               | 50 8          | 3 47           | 6           |
| * Eddystone Li.           | 50 8          | 4 18           | 5           |
| Land Deep                 | 50 14         | 4 22           | 5           |

|                        | Lat.<br>D. M. | Long.<br>D. M. | H. W.<br>H. |
|------------------------|---------------|----------------|-------------|
| Ram Head               | 50 18N.       | 4 15W          | 5           |
| * Plymouth             | 50 22         | 4 10           | 6           |
| Fowey                  | 50 17         | 4 47           | 5           |
| * Deadman's Pt.        | 50 12         | 4 54           | 5           |
| * Falmouth             | 50 8          | 5 5            | 5           |
| Manacles Rocks         | 50 2          | 5 6            | 5           |
| Black Head             | 50 5          | 5 10           | 5           |
| * Lizard Point         | 49 57         | 5 14           | 5           |
| Mount's Bay            | 50 8          | 5 37           | 5           |
| Runnel Stone           | 50 2          | 5 48           | 5           |
| Wolf Rock              | 49 56         | 6 30           | 4           |
| Land's End             | 50 6          | 5 55           | 4           |
| Scilly Islands S. part | 49 52         |                |             |
| * St. Agnes Lts.       |               |                |             |
| Scilly                 | 49 54         | 6 42           | 4           |
| * St. Mary's, do.      | 49 57         | 6 36           | 4           |

The current in the mid. channel is N. E. about 1 H. 30 M. after high water; and it runs off Dungeness 4 H. to 4 and an half hours; in the Downs 4 hours; and east in the King's channel, 3 hours after high water.

The following table shews the time of high water at the principal headlands, &c. in the Channel, on full and change, days, and the time the current runs after high water.

The current runs after H. W.

| High Water.              | H. M. | H. M. | H. M. |
|--------------------------|-------|-------|-------|
| At the Lizard at         | 5 0   | 3 0   | 8     |
| Off the Eddystone        | 5 30  | 3 0   | 8 30  |
| Off the Start            | 6 10  | 2 30  | 8 30  |
| Off Portland             | 7 15  | 3 0   | 10 15 |
| Off I. of Wight          | 8 14  | 3 15  | 11 30 |
| Off Arundel and Shoreham | 9 15  | 1 15  | 10 30 |
| Off Beachy               | 9 45  | 1 15  | 11    |
| Off Dungeness            | 10 30 | 4 0   | 2 30  |

NOTE. H. W. stands for high water; R. for river; I. for island; P. for point, and C. for cape.

NOTE. The variation in the English, and St. George's channels, is  $25^{\circ} 30'$ , and on the east coast of England  $25^{\circ}$  west, and the Orkneys and Shetland islands about  $2\frac{1}{2}$  Points, on the western coast of Ireland  $2\frac{1}{2}$  points west, and is found to vary between 11 and 12 minutes westerly every year, or a degree in  $5\frac{1}{2}$  years, therefore, by adding a degree for every  $5\frac{1}{2}$  years to the variation here given for 1793, you will have the variation nearly for any succeeding year.

TABLE XXIV. OF LATITUDES, AND LONGITUDES.

*From the North Foreland to  
Duncan's Bay Head.*

|                                        | Lat.<br>D. M. | Long.<br>D. M. | H. W.<br>H. |
|----------------------------------------|---------------|----------------|-------------|
| *North Foreland                        | 51 25 N.      | 1 32 E         | 11          |
| Kentish Knock                          | 51 43         | 1 45           | 11          |
| Long Sand Head                         | 51 48         | 1 45           | 11          |
| Galloper N. P.                         | 51 58         | 2 0            | 12          |
| Ditto South P.                         | 51 48         | 1 59           | 12          |
| Shipwash N. P.                         | 52 9          | 1 43           | 12          |
| Ditto South P.                         | 52 2          | 1 39           | 12          |
| Gabbard —                              | 52 5          | 1 45           | 12          |
| Orfordness                             | 52 13         | 1 40           | 10          |
| Aldboro' knaps,<br>South P.            | 52 15         | 1 49           | 9           |
| Southwold                              | 52 28         | 1 37           | 9           |
| Leafluff Lights                        | 52 38         | 1 49           | 9           |
| * Yarmouth                             | 52 39         | 1 45           | 8           |
| Winterton Ness<br>Lights               | 52 49         | 1 40           | 8           |
| Smiths Knowl                           | 52 57         | 2 20           |             |
| Haitborough<br>Sand, S. P.             | 52 54         | 1 48           | 7           |
| Ditto, North P.                        | 53 6          | 1 32           | 7           |
| Cromer Lights                          | 53 3          | 1 16           | 9           |
| Lemon and Ow-<br>er, North P.          | 53 23         | 1 43           |             |
| Ditto, South P.                        | 53 13         | 1 45           |             |
| Cromer Bank                            | 53 21         | 1 30           |             |
| Dudgeon Lights                         | 53 26         | 1 0            | 7           |
| Outer Dowlings                         | 53 40         | 1 0            |             |
| Inner Dowlings                         | 53 22         | 0 50           | 5           |
| Lynn Deep                              | 53 0          | 0 27           | 6           |
| Spurn Lights                           | 53 41         | 0 22           | 5           |
| * Flamborough<br>Head                  | 54 10         | 0 7            | 4           |
| Filey Brig                             | 54 17         | 0 5 W          | 4           |
| Scarborough                            | 54 21         | 0 13           | 4           |
| Robin Hood's<br>Bay                    | 4 30          | 0 22           | 3           |
| Whitby —                               | 54 34         | 0 27           | 3           |
| River Tee's<br>Mouth,                  |               |                |             |
| Stockton —                             | 54 41         | 0 59           | 3           |
| River Tee's<br>Mouth, New-<br>castle — | 55 2          | 1 9            | 3           |
| Coquet Island                          | 55 22         | 1 21           | 2           |
| Staples Islands                        | 55 39         | 1 40           | 2           |
| Holy Island                            | 55 42         | 1 48           | 2           |
| Berwick —                              | 55 47         | 2 1            | 2           |
| St. Abb's Head                         | 55 57         | 2 6            | 4           |
| Dunbar —                               | 55 59         | 2 29           | 2           |
| May I. Lights                          | 56 11         | 2 32           | 2           |
| * EDINBURGH                            | 55 58         | 3 9            | 2           |
| Fife Ness —                            | 56 15         | 2 33           | 4           |
| Mouth of Tay                           | 56 27         | 2 38           | 3           |
| C. Rock, off do.                       | 56 29         | 2 22           | 3           |
| Red Head —                             | 56 38         | 2 28           | 3           |
| Montrose —                             | 56 44         | 2 24           | 1           |
| New Aberdeen                           | 57 7          | 2 4            | 12          |
| Peter Head                             | 57 34         | 1 42           | 12          |
| Buchan Ness                            | 57 31         | 1 42           | 12          |
| Kinnaird's Head                        | 57 39         | 1 56           | 12          |
| Bamff —                                | 57 38         | 2 27           | 11          |

|                 | Lat.<br>D. M. | Long.<br>D. M. | H. W.<br>H. |
|-----------------|---------------|----------------|-------------|
| Fort St. George | 57 38 N.      | 4 1 W          | 11          |
| Inver Ness      | 57 23         | 3 45           | 11          |
| Cromartie —     | 57 42         | 3 56           | 11          |
| Tarbet Ness     | 57 54         | 3 44           | 11          |
| Caithness —     | 58 20         | 3 3            | 11          |
| Nose Head —     | 58 28         | 3 4            | 11          |
| Duncansby Head  | 58 40         | 3 3            | 11          |

*The Orkney Islands.*

|                                            |          |        |    |
|--------------------------------------------|----------|--------|----|
| Pentland Sker-<br>ries —                   | 58 45 N. | 2 57 W | 11 |
| Stromo —                                   | 58 45    | 2 59   | 11 |
| South Renald-<br>sha, South P.             | 58 47    | 2 52   | 11 |
| Copinsha —                                 | 58 53    | 2 41   | 11 |
| Lambs Head, on<br>Stronsal I.              | 59 4     | 2 29   | 11 |
| North Ronald-<br>sha, North P.             | 59 23    | 2 22   | 10 |
| Mould Head, on<br>Patra Westra<br>Island — | 59 21    | 2 52   | 9  |
| Noup Head, on<br>Westra I.                 | 59 18    | 3 2    | 9  |
| Marwick Head,<br>on Pomona I.              | 59 6     | 3 16   | 10 |
| Hoy Head, on<br>Hoy Wells I.               | 58 55    | 3 18   | 10 |
| Sluc Skerry                                | 59 3     | 3 24   | 10 |
| Fair Island                                | 59 30    | 1 42   | 4  |

*The Shetland Islands.*

|                             |         |        |   |
|-----------------------------|---------|--------|---|
| Sumbug Head,<br>South Point | 59 52 N | 1 15 W | 4 |
| Rose or Hangliff            | 60 9    | 0 58   | 4 |
| Brassa Sound,<br>Larwick    | 60 13   | 0 51   | 4 |
| Out Skerries                | 60 25   | 0 18   | 4 |
| Walsey Isle                 | 60 25   | 0 46   | 4 |
| Unfet, N. E. P.             | 60 47   | 0 15   | 4 |
| Foul Island                 | 60 25   | 1 50   | 3 |

*Ferro Islands.*

|                                                           |          |        |   |
|-----------------------------------------------------------|----------|--------|---|
| The Munk Rock,<br>appears like a<br>Ship under Sail       | 61 18 N. | 6 47 W | 3 |
| Fulae I. N.<br>part of Ferro                              | 62 12    | 6 27   | 4 |
| East Point of<br>Mygenes Isl.<br>N. W. part of<br>Ferro — | 62 3     | 7 32   | 4 |

*From Duncan's Bay Head to the  
Land's-End.*

|                              |          |       |    |
|------------------------------|----------|-------|----|
| Duncansby Head               | 58 40 N. | 3 3 W | 11 |
| Dunnet Head                  | 58 44    | 3 18  | 11 |
| Faront Head                  | 58 36    | 5 0   | 11 |
| Cape Wrath, or<br>Barre Head | 58 36    | 5 20  | 7  |
| A Rock seen at<br>½ Ebb      | 58 45    | 5 21  | 7  |

TABLE XXIV. OF LATITUDES AND LONGITUDES.

|                   | Lat.<br>D. M. | Long.<br>D. M. | H. W.<br>H. |                         | Lat.<br>D. M. | Long.<br>D. M. | H. W.<br>H. |
|-------------------|---------------|----------------|-------------|-------------------------|---------------|----------------|-------------|
| Bara I. —         | 58 54N.       | 6 26W          |             | Mort P. S. En-          | 51 15N.       | 4 15W          |             |
| Rena Island       | 58 55         | 6 15           | 7           | trance of ditto         | 51 4          | 4 38           |             |
| Rockal —          | 57 28         | 13 32          |             | Hartland P.             | 50 42         | 4 55           |             |
| St. Kilda         | 57 51         | 8 56           |             | Padstow —               | 50 30         | 5 7            |             |
| Butt of the Lewis | 58 29         | 6 34           | 5           | Towan Head              | 50 17         | 5 34           |             |
| Gallan Head       | 58 10         | 7 24           | 4           | St. Ives Bay            | 50 10         | 5 55           |             |
| Flannan I.        | 58 13         | 7 50           | 4           | Cape Cornwall           | 50 6          | 6 23           |             |
| Hiskere I.        | 57 23         | 7 58           | 5           | The Seven Stones        | 49 57         | 6 2            |             |
| Bara Head         | 56 56         | 7 44           | 5           | The Wolf Rock           | 50 6          | 5 55           |             |
| Rocks very dan-   |               |                |             | The Land's End          |               |                |             |
| gerous —          | 56 55         | 7 7            | 5           | <i>The Isle of Man.</i> |               |                |             |
| Canal Islands     | 57 03         | 6 52           | 5           | Calf of Man             | 54 1          | 5 3            | 10          |
| Hysker Islands    | 56 56         | 6 58           | 5           | Douglas —               | 54 7          | 4 42           |             |
| Rum I. West P.    | 56 59         | 6 46           | 5           | Ramsey Bay              | 54 17         | 4 38           | 10          |
| Tircey I. S. P.   | 56 30         | 7 12           | 5           | Point of Air            | 54 25         | 4 34           | 10          |
| Colt I. North P.  | 56 42         | 6 45           | 5           | Peel Hill —             | 54 12         | 4 57           | 10          |
| Bomthly Rocks     | 56 9          | 7 5            | 5           | <i>Ireland.</i>         |               |                |             |
| Skerryvore        | 56 17         | 7 22           | 5           | Cape Clear              | 51 15N.       | 9 50W          | 3           |
| Ila I. S. W. P.   | 55 47         | 6 44           | 10          | Fainet Rock             | 51 13         | 9 55           | 3           |
| Ditto, South P.   | 55 39         | 6 30           | 10          | Crookhaven              | 51 19         | 10 5           | 4           |
| Rachlan I. E.     |               |                |             | Mizen Head              | 51 18         | 10 13          | 3           |
| Part —            | 55 17         | 6 17           | 9           | Sheeps Head             | 51 24         | 10 15          | 3           |
| Mull of Cantire   |               |                |             | Bantry Bay              | 51 26         | 10 10          | 3           |
| Light-House       | 55 21         | 6 0            | 11          | Grelah Rocks            | 51 22         | 10 41          | 3           |
| I. of Arran, S.   |               |                |             | Dursey I. W. P          | 51 26         | 10 45          | 3           |
| E. Part —         | 55 32         | 5 20           | 11          | Bull Rock               | 51 27         | 10 45          | 3           |
| Cumray I. En-     |               |                |             | Cow Rock                | 51 27         | 10 48          | 3           |
| trance of Clyde   | 55 47         | 5 17           | 11          | Cod's Head              | 51 32         | 10 32          | 3           |
| Elfa I. —         | 55 16         | 5 24           | 11          | Kenmare Bay             | 51 35         | 10 50          | 3           |
| Irwin —           | 55 36         | 5 0            | 11          | Lamb Head               | 51 38         | 10 37          | 3           |
| Air —             | 55 26         | 4 57           | 11          | Hog I. —                | 51 37         | 10 49          | 3           |
| Loch Ryan         | 50 3          | 5 21           | 11          | Hog's Head              | 51 41         | 10 48          | 3           |
| Port Patrick Lts  | 54 48         | 5 20           | 11          | Polus Head              | 51 41         | 10 55          | 3           |
| Mull of Gallo-    |               |                |             | Skelling's Rocks        | 51 40         | 11 10          | 3           |
| way —             | 54 37         | 5 8            | 11          | Lemon Rock              | 51 42         | 11 2           | 3           |
| Great Scar I.     | 54 40         | 4 57           | 11          | Bray Head —             | 51 47         | 11 49          | 3           |
| Burrow Head       | 54 41         | 4 39           | 11          | Diggle Bay              | 51 55         | 11 0           | 3           |
| Solway Firth      | 54 47         | 4 30           | 11          | Foze Rock               | 51 54         | 11 14          | 3           |
| St. Bee's Head    |               |                |             | Fretter's I.            | 51 56         | 11 22          | 3           |
| Light —           | 54 30         | 3 50           | 11          | Tiraght Rocks           | 51 57         | 11 24          | 3           |
| Whitehaven        | 54 32         | 3 47           | 11          | Great Blasket           | 51 57         | 11 9           | 3           |
| Selker Rock       | 54 16         | 3 39           | 11          | Ennis Tuskan            | 52 0          | 11 23          | 3           |
| Lancaster —       | 54 3          | 3 3            | 11          | Dunmore Head            | 51 59         | 10 55          | 3           |
| Liverpool —       | 53 27         | 3 12           | 11          | Dunorling Head          | 52 5          | 10 57          | 3           |
| Great Orms Hd.    | 53 20         | 4 3            | 10          | Brandon Head            | 52 9          | 10 46          | 3           |
| Skerries Light    | 53 25         | 4 50           | 9           | The Seven Hogs          |               |                |             |
| Holyhead —        | 53 19         | 4 52           | 9           | Rocks —                 | 52 11         | 10 37          | 3           |
| Brachy Pool Hd.   | 52 47         | 4 57           | 7           | Kerry Head              |               |                |             |
| Bardsey I. —      | 52 45         | 5 0            | 7           | Entrance of             |               |                |             |
| Barmouth —        | 52 48         | 4 12           | 8           | Shannon Riv.            | 52 15         | 10 32          | 3           |
| Cardigan Har-     |               |                |             | Loop Head, N.           |               |                |             |
| bour —            | 52 12         | 4 47           | 7           | Entrance Ditto          | 52 23         | 10 33          | 3           |
| Strumble Head     | 52 0          | 5 10           | 7           | North Arran, or         |               |                |             |
| St. David's Head  | 51 55         | 5 20           | 6           | Killaury —              | 53 6          | 10 17          | 4           |
| Ramsey I. —       | 51 48         | 5 21           | 6           | Galway Bay              | 53 9          | 9 59           | 4           |
| Small's Light-    |               |                |             | Slieve Head             | 53 23         | 10 49          | 4           |
| House —           | 51 48         | 5 36           | 9           | Ennis Shark I.          | 53 34         | 10 52          | 4           |
| St. Ann's ditto,  |               |                |             | Ennis Turk I.           | 53 40         | 10 42          | 4           |
| Milford Haven     | 51 44         | 5 10           | 5           | Clare Island            | 53 45         | 10 36          | 4           |
| Worms Head        | 51 35         | 4 22           | 5           | Achill Head             | 53 56         | 10 49          | 4           |
| Caldy I. —        | 51 43         | 4 42           | 5           | Black Rock              | 54 2          | 10 53          | 5           |
| Lundy I. En-      |               |                |             | Urris Head              | 54 18         | 10 37          | 5           |
| trance of Brif-   |               |                |             |                         |               |                |             |
| tol Channel       | 51 15         | 4 44           | 5           |                         |               |                |             |



TABLE XXIV. OF LATITUDES AND LONGITUDES.

|                  | Dat.<br>D. M. | Long.<br>D. M. | H. W.<br>H. |                         | Dat.<br>D. M. | Long.<br>D. M. |
|------------------|---------------|----------------|-------------|-------------------------|---------------|----------------|
| Broad Haven      | 54 15 N.      | 10 29 W        | 5           | Goree I.                | 51 53 N.      | 3 58 E.        |
| Stag Rocks, off  |               |                |             | Schowen I.              | 51 47         | 3 43           |
| Broad Haven      | 54 21         | 10 24          | 5           | * North Gatt            | 52 1          | 4 9            |
| Down Patrick     |               |                |             | * Rotterdam             | 51 56         | 4 34           |
| Head             | 54 18         | 9 58           | 5           | * AMSTERDAM             | 51 23         | 4 51           |
| Sligo Bay        | 54 15         | 9 18           | 5           | Texel                   | 53 10         | 4 52           |
| Ennis Murray I.  | 54 24         | 9 18           | 5           | Bremen                  | 53 23         | 10 28          |
| Donegal Bay      | 54 30         | 9 6            | 5           | Elbe River, Entrance of | 54 4          | 10 1           |
| Tillon Head      | 54 38         | 9 25           | 5           | Hilige Land Light       | 54 11         | 9 37           |
| Arranmore        | 54 58         | 9 8            | 5           | Holmen                  | 57 1          | 8 38           |
| Tory Island      | 55 15         | 8 48           | 4           | Robsnout                | 57 30         | 9 49           |
| Lock Swilly      | 55 17         | 8 0            | 5           | Scaw                    | 57 42         | 10 3           |
| Malin Head       | 55 24         | 7 48           | 4           |                         |               |                |
| Ennistrahul      |               |                |             |                         |               |                |
| Rocks            | 55 29         | 7 35           | 4           |                         |               |                |
| Inishoan Head    |               |                |             |                         |               |                |
| Entrance of      |               |                |             |                         |               |                |
| Londonderry      | 55 16         | 7 16           | 4           |                         |               |                |
| Bengore Head     | 55 18         | 6 44           | 4           |                         |               |                |
| Racklin I. West  |               |                |             |                         |               |                |
| Point            | 55 21         | 6 32           | 8           |                         |               |                |
| Fair Head        | 55 15         | 6 22           | 10          |                         |               |                |
| The Maid's       |               |                |             |                         |               |                |
| Rocks            | 54 55         | 5 46           | 10          |                         |               |                |
| Belfast loch     | 54 43         | 5 45           | 10          |                         |               |                |
| Copeland Lights  | 54 41         | 5 33           | 10          |                         |               |                |
| St. John's P.    | 54 12         | 5 49           | 11          |                         |               |                |
| Dundrum          | 54 13         | 6 0            | 11          |                         |               |                |
| Carlingford loch | 54 0          | 6 12           | 10          |                         |               |                |
| Dundalk          | 53 57         | 6 27           | 10          |                         |               |                |
| Drogheda Bar     | 53 45         | 6 22           | 11          |                         |               |                |
| St. Patrick's I. | 53 36         | 6 10           | 11          |                         |               |                |
| Lambay Island    | 53 31         | 6 7            | 11          |                         |               |                |
| DUBLIN           | 53 22         | 6 22           | 11          |                         |               |                |
| Wicklow Lights   | 52 59         | 6 7            | 10          |                         |               |                |
| Wexford          | 52 22         | 6 30           | 8           |                         |               |                |
| Tucker Rock      | 52 12         | 6 14           | 8           |                         |               |                |
| Carnfore P.      | 52 11         | 6 23           | 8           |                         |               |                |
| The Saltee Rocks | 52 5          | 6 36           | 5           |                         |               |                |
| Hook Lights,     |               |                |             |                         |               |                |
| Waterford        |               |                |             |                         |               |                |
| Harbour          | 52 3          | 7 3            | 4           |                         |               |                |
| Dungarvon        | 51 59         | 7 36           | 5           |                         |               |                |
| Helwick Head     | 51 57         | 7 36           | 5           |                         |               |                |
| Youghall         | 51 50         | 7 53           | 5           |                         |               |                |
| Cork Harbour     | 51 41         | 8 23           | 4           |                         |               |                |
| Kinfale Harbour  | 51 34         | 8 42           | 4           |                         |               |                |
| Old Head of      |               |                |             |                         |               |                |
| Kinfale          | 51 30         | 8 42           | 4           |                         |               |                |
| Seven Heads      | 51 27         | 8 52           | 4           |                         |               |                |
| Dundedy Head     | 51 25         | 9 8            | 4           |                         |               |                |
| The Stags, off   |               |                |             |                         |               |                |
| Toe Head         | 51 19         | 9 23           | 4           |                         |               |                |
| Baltimore Har-   |               |                |             |                         |               |                |
| bour             | 51 20         | 9 40           | 4           |                         |               |                |

From Calais to the Scaw.

|                      |         |         |
|----------------------|---------|---------|
| * Calais             | 50 57 N | 1 57 E. |
| Gravelines           | 51 0    | 2 15    |
| * Dunkirk            | 51 2    | 2 28    |
| * Newport            | 51 8    | 2 51    |
| * Ostend             | 51 14   | 3 2     |
| Walcheren I. West P. | 51 32   | 3 26    |

From the Scaw to St. Petersburg.

|                      |          |         |
|----------------------|----------|---------|
| * Naze of Norway     | 57 59 N. | 7 13 E. |
| Fer Light            | 59 20    | 10 8    |
| Christiana           | 59 50    | 10 20   |
| Frederickstad        | 59 10    | 10 35   |
| Paternosters         | 57 54    | 11 32   |
| Marstrand light      | 57 54    | 11 40   |
| Wingo Beacon         | 57 38    | 11 48   |
| Gothenburgh          | 57 42    | 11 45   |
| Leifso I. East P.    | 57 20    | 11 9    |
| West P.              | 57 17    | 10 51   |
| Trindelen Rock       | 57 28    | 11 15   |
| Kummel Bank          | 57 27    | 11 21   |
| Nidigen light        | 57 18    | 12 1    |
| Warberg              | 57 7     | 12 19   |
| Falkenburgh          | 56 54    | 12 34   |
| Halmstad             | 56 40    | 12 56   |
| Halland's I. Wadero  | 56 26    | 12 36   |
| Koll Light           | 56 19    | 12 33   |
| Anholt light         | 56 44    | 11 36   |
| Hafelo I.            | 56 12    | 12 48   |
| Hielm I.             | 56 10    | 10 54   |
| Cronenburgh Light    | 56 3     | 12 42   |
| * Elfeneur           | 56 1     | 12 41   |
| Huen I. North P.     | 55 55    | 12 44   |
| * Lendserone         | 56 8     | 12 3    |
| * COPENHAGEN         | 55 41    | 12 41   |
| Saltholm, North P.   | 55 41    | 12 51   |
| Faltrebo light       | 55 21    | 12 53   |
| Lubek                | 53 51    | 10 50   |
| Dars Head            | 54 28    | 12 40   |
| Bornholm I. N. E. P. | 55 19    | 14 54   |
| S. W. P.             | 54 57    | 15 17   |
| * Dantzick           | 54 22    | 18 40   |
| Oland, North P.      | 56 11    | 16 29   |
| South P.             | 57 24    | 17 9    |
| Gotland, North P.    | 56 55    | 18 16   |
| South P.             | 57 55    | 19 37   |
| Goltske I.           | 58 16    | 19 27   |
| Memel                | 55 24    | 21 6    |
| Swaferort lights     | 57 55    | 22 1    |
| Domes Nefs light     | 57 48    | 22 30   |
| Runoe light          | 57 49    | 23 12   |
| Riga                 | 57 2     | 23 45   |
| Dagerort Light       | 58 56    | 22 3    |
| Hengo Light          | 59 49    | 23 2    |
| * STOCKHOLM          | 59 21    | 18 9    |
| * St. Petersburg     | 59 56    | 30 25   |

TABLE XXIV. OF LATITUDES AND LONGITUDES.

| <i>From the Naze to Archangel.</i>          |        |       |       |                  |        |       |  |
|---------------------------------------------|--------|-------|-------|------------------|--------|-------|--|
|                                             | Lat.   | Long. |       | Lat.             | Long.  | H. W. |  |
|                                             | D. M.  | D. M. |       | D. M.            | D. M.  | H.    |  |
| * The Naze                                  | 47 59N | 7 13E |       | * Avranché       | 48 41N | 1 17W |  |
| Judder, or Walbert's Hd.                    | 58 34  | 5 55  |       | * St. Malo       | 48 39  | 1 56  |  |
| Litter Land                                 | 58 9   | 6 45  |       | Cape Frehel      | 48 48  | 2 22  |  |
| Rutt's I.                                   | 58 42  | 5 58  |       | St. Brieux       | 48 32  | 2 48  |  |
| Great Wylingfoe Light-                      |        |       |       | De Brahat I.     | 48 52  | 2 52  |  |
| Houfe                                       | 58 56  | 5 50  |       | Roche Blanche    | 48 59  | 3 52  |  |
| Stavanger                                   | 58 56  | 6 5   |       | * St. Anthony's  |        |       |  |
| Ulster's I.                                 | 59 54  | 5 20  |       | Lights           | 48 40  | 4 24  |  |
| Bergen                                      | 60 12  | 5 50  |       | * Ushant, W. Pt. | 48 29  | 4 58  |  |
| Mus Sound                                   | 60 18  | 5 30  |       | * Brest          | 48 23  | 4 25  |  |
| Sillewoog I.                                | 60 36  | 5 21  |       | Point Raz        | 48 2   | 4 40  |  |
| Kate Nofe                                   | 61 25  | 5 42  |       | Point L'Abbe     | 47 48  | 4 11  |  |
| * Dronthemn, Var. 2 P.                      |        |       |       | Isles de Glenan  | 47 44  | 4 0   |  |
| West                                        | 63 26  | 11 10 |       | L'Orient         | 47 44  | 3 21  |  |
| * Werro I. Var. 1 ½ P.                      |        |       |       | Isle de Groa     | 47 36  | 3 28  |  |
| West                                        | 67 43  | 9 7   |       | Guiberon         | 47 34  | 3 5   |  |
| * North Cape, Var. 1 P.                     |        |       |       | * Belle Isle     | 47 17  | 3 1   |  |
| West                                        | 71 10  | 26 10 |       | Houat Isle       | 47 20  | 2 57  |  |
| Fishers I. Var. 1 P. W.                     | 70 2   | 32 5  |       | Dumet Isle       | 47 15  | 2 52  |  |
| Kildume I. Var. ¼ P.                        |        |       |       | * Nantes         | 47 13  | 1 25  |  |
| West                                        | 69 18  | 33 45 |       | Nourmouster I.   | 47 2   | 2 10  |  |
| * Rivea Kola, Entrance,                     |        |       |       | Dieu Isle        | 46 42  | 2 16  |  |
| Var. ½ P. West                              | 69 13  | 33 35 |       | * Roche Bon      | 46 14  | 2 21  |  |
| Sweetnose, Var. ½ P. W.                     | 68 0   | 37 30 |       | Ree Isle         | 46 15  | 1 28  |  |
| Orlogenosé                                  | 67 0   | 39 23 |       | * Rochelle       | 46 9   | 1 4   |  |
| Crois I. Var. ½ P. W.                       | 66 19  | 38 50 |       | * Rochfort       | 46 3   | 0 53  |  |
| Ponoy R. Var. ¼ P. W.                       | 66 58  | 39 46 |       | Oleron Isle      | 46 3   | 1 19  |  |
| * Archangel, Var. ¼ P.                      |        |       |       | Cordovan Light   |        |       |  |
| West                                        | 64 30  | 39 0  |       | Houfe            | 45 36  | 1 6   |  |
| Catnose or blue Point                       | 65 21  | 38 12 |       | * Bourdeaux      | 44 50  | 0 30  |  |
| C. Bona Fortune                             | 66 23  | 40 28 |       | C. Feret         | 44 43  | 1 10  |  |
| C. Candinose                                | 68 22  | 41 25 |       | * Bayonne        | 43 29  | 1 24  |  |
| Weigate's Straits                           | 69 30  | 62 2  |       | C. Machicaco     | 43 31  | 3 15  |  |
| Nova Zembla                                 | 78 0   | 70 0  |       | Bilboa           | 43 15  | 3 1   |  |
| <i>Coasts of France, Spain and Portugal</i> |        |       |       | C. de Lata       | 43 34  | 3 53  |  |
| <i>from Calais to Gibraltar.</i>            |        |       |       | C. Penas         | 43 48  | 5 48  |  |
| * Calais                                    | 50 58N | 1 57E | H. W. | * C. Ortegal     | 43 46  | 7 36  |  |
| Cape Griz Nez                               | 50 58  | 1 40  | 3 ¼   | C. Prior         | 43 31  | 8 8   |  |
| Boulogne                                    | 50 44  | 1 44  |       | Ferrol           | 43 30  | 8 0   |  |
| Etaples                                     | 50 31  | 1 47  |       | Corunna          | 43 17  | 8 12  |  |
| St. Vallery                                 | 49 52  | 0 47  |       | C. Belem         | 43 10  | 9 13  |  |
| * Dieppe                                    | 49 55  | 1 10  | 11    | C. Turiana       | 43 4   | 9 21  |  |
| Fecamp                                      | 49 50  | 0 30  | 11    | * C. Finistère   | 42 52  | 9 14  |  |
| * Havre de Grace                            | 49 29  | 0 12  | 9     | Vigo Bay         | 42 14  | 8 34  |  |
| Mouth of the                                |        |       |       | C. Fasilis       | 42 5   | 8 50  |  |
| Seine                                       | 49 27  | 0 10W | 9     | * Oporto         | 41 20  | 8 21  |  |
| Caen                                        | 49 11  | 0 16  | 11    | C. Mondego       | 40 5   | 8 46  |  |
| Cape Barfleur                               |        |       |       | C. Fifeaon       | 39 24  | 9 10  |  |
| Lights                                      | 49 44  | 1 7   | 10 ¼  | The Burlings     | 39 20  | 9 31  |  |
| Cherbourg                                   | 49 38  | 1 32  | 7 ¼   | * The Rock of    |        |       |  |
| C. St. Germain                              | 49 46  | 1 52  | 9     | Lisbon           | 38 45  | 9 31  |  |
| Alderney I. W.                              |        |       |       | * Lisbon         | 38 42  | 9 7   |  |
| Point                                       | 49 48  | 2 12  | 9     | C. Epichel       | 38 21  | 9 15  |  |
| Caskett Lights                              | 49 48  | 2 25  | 10    | St. Ubes         | 38 29  | 9 0   |  |
| Guernsey I. W.                              |        |       |       | * C. St. Vincent | 37 2   | 8 56  |  |
| Point                                       | 49 32  | 2 36  |       | C. St. Mary      | 37 0   | 7 55  |  |
| Sark I. N. Point                            | 48 28  | 2 16  |       | P. Avenisla      | 37 6   | 6 53  |  |
| Jersey I. N. W.                             |        |       |       | * Cadiz          | 36 31  | 6 6   |  |
| Point                                       | 49 16  | 2 17  | 6     | C. Trafalgar     | 36 10  | 5 56  |  |
| * Coutance                                  | 49 3   | 1 21  | 6     | * Gibraltar      | 36 5   | 5 16  |  |
| * Grantville                                | 48 50  | 1 31  | 6     | Ceuta            | 35 50  | 5 12  |  |
|                                             |        |       |       | * C. Sparte      | 35 48  | 5 48  |  |

TABLE XXIV. OF LATITUDES AND LONGITUDES.

*The North Coast of the Mediterranean Sea, from Gibraltar to Constantinople.*

|                                                   | Lat.<br>D. M. | Long.<br>D. M. |
|---------------------------------------------------|---------------|----------------|
| * Gibraltar                                       | 36 5N.        | 5 16W          |
| Malaga                                            | 36 42         | 4 15           |
| * Cape de Gatt                                    | 36 46         | 2 24           |
| * Carthage                                        | 37 37         | 1 2            |
| * Cape Pallas                                     | 37 34         | 0 58           |
| Alicant                                           | 38 25         | 0 9            |
| Cape St. Martin                                   | 38 47         | 0 5E.          |
| Gandia                                            | 39 1          | 0 0W           |
| Valentia                                          | 39 30         | 0 32           |
| Cape Oropefo                                      | 40 0          | 0 7            |
| River Ebro                                        | 40 44         | 0 30E.         |
| * Barcelona                                       | 41 26         | 2 18           |
| Cape Sebastian                                    | 41 48         | 3 15           |
| Cape de Creux                                     | 42 18         | 3 23           |
| Perpignan                                         | 42 30         | 2 57           |
| Cette                                             | 43 24         | 3 46           |
| Narbonne Road                                     | 43 0          | 2 55           |
| Montpelier                                        | 43 37         | 3 49           |
| Mountfort                                         | 43 39         | 5 0            |
| * Marseilles                                      | 43 18         | 5 28           |
| * Toulon                                          | 43 7          | 6 3            |
| Cape Taillar                                      | 43 4          | 6 56           |
| Cape de Orope                                     | 43 29         | 7 21           |
| Villa France                                      | 43 42         | 7 25           |
| Cape de Mille                                     | 43 54         | 7 56           |
| * Genoa                                           | 44 25         | 8 41           |
| Point de Fino                                     | 44 16         | 9 0            |
| * Leghorn                                         | 43 27         | 10 27          |
| Cape M. Nero                                      | 43 18         | 10 0           |
| Vada                                              | 43 15         | 10 35          |
| Piombino                                          | 43 0          | 10 33          |
| Point Ercore                                      | 42 29         | 11 1           |
| * Civita Vecchia                                  | 42 5          | 11 52          |
| * Rome                                            | 41 54         | 12 35          |
| Cape Dazzia                                       | 41 38         | 12 35          |
| * Naples                                          | 40 51         | 14 20          |
| Cape Polonado                                     | 40 3          | 15 28          |
| Policastro                                        | 41 17         | 15 53          |
| Cape Batican                                      | 38 47         | 16 35          |
| Cape Grofe                                        | 38 17         | 16 16          |
| Cape Spartevento                                  | 38 0          | 16 57          |
| Cape Collonia                                     | 39 0          | 18 8           |
| Taranto                                           | 40 14         | 18 2           |
| Galipoli                                          | 39 56         | 18 36          |
| Cape St. Mary, the Entrance to the Gulf of Venice | 39 40         | 19 14          |
| Brinici                                           | 40 38         | 18 45          |
| Barry                                             | 41 4          | 17 18          |
| Manfredonia                                       | 41 40         | 16 10          |
| Cape Vestio                                       | 41 43         | 16 34          |
| Pescara                                           | 43 13         | 14 30          |
| * Ancona                                          | 43 38         | 13 37          |
| Comago                                            | 44 25         | 12 0           |
| * Venice                                          | 45 26         | 12 10          |
| Triefte                                           | 46 0          | 13 34          |
| Rovigno                                           | 45 11         | 13 48          |
| St. Maria                                         | 45 23         | 14 25          |
| Pescera                                           | 44 42         | 15 40          |
| Cape Sesto                                        | 43 45         | 16 25          |

|                         | Lat.<br>D. M. | Long.<br>D. M. |
|-------------------------|---------------|----------------|
| Rosaro                  | 42 48N.       | 17 40E.        |
| Patero                  | 42 23         | 19 15          |
| Dorazo                  | 41 40         | 18 45          |
| La Vallona              | 40 53         | 20 8           |
| Cape Liqueta            | 40 42         | 19 30          |
| Pageni                  | 39 19         | 21 28          |
| Larta                   | 38 55         | 22 3           |
| Cape de Larta           | 38 40         | 21 44          |
| Lepanto                 | 38 15         | 22 54          |
| Cape Gallo              | 36 40         | 21 49          |
| Cape Mantapan           | 36 35         | 22 37          |
| Cape St. Angelc         | 36 37         | 23 44          |
| Cape Mala               | 37 34         | 24 13          |
| Corinth                 | 38 10         | 23 35          |
| * Athens                | 38 4          | 23 58          |
| Negropont               | 38 28         | 24 10          |
| Cape Doro               | 38 0          | 25 0           |
| Cape St. George         | 39 10         | 23 44          |
| * Salonica or Salonique | 40 41         | 23 14          |
| Cape Ballouri           | 39 43         | 23 55          |
| Cape Pellice            | 39 57         | 24 25          |
| Cape Monte Santo        | 40 10         | 24 57          |
| Adrianople              | 40 44         | 27 5           |
| Galipoli                | 40 25         | 27 11          |
| * CONSTANTINOPLE        | 41 1          | 29 0           |

*The South Coast of the Mediterranean Sea.*

|               | Lat.<br>D. M. | Long.<br>D. M. |
|---------------|---------------|----------------|
| Ceuta         | 35 50N.       | 5 14W          |
| C. Tetuan     | 35 28         | 5 14           |
| C. Negril     | 35 25         | 4 24           |
| * C. 3 Forcas | 35 38         | 2 45           |
| C. Fegalle    | 36 46         | 1 2            |
| * C. Falcon   | 36 6          | 0 44           |
| C. Ferrat     | 36 4          | 0 3E.          |
| C. Tennis     | 36 35         | 1 12           |
| * Algiers     | 36 49         | 2 19           |
| C. Matifor    | 36 52         | 3 3            |
| * C. Carbon   | 36 53         | 4 15           |
| C. Tones      | 37 4          | 5 44           |
| C. Fyel       | 36 58         | 6 37           |
| C. Ferro      | 37 4          | 7 33           |
| Bona          | 36 45         | 7 53           |
| Tabarca       | 37 8          | 8 55           |
| C. Serra      | 37 25         | 9 35           |
| C. Blanc      | 37 30         | 9 35           |
| Tunis         | 36 45         | 10 10          |
| C. Bon        | 37 9          | 11 8           |
| Sufa          | 35 44         | 10 50          |
| C. Paul       | 35 5          | 11 15          |
| Cape de Zoara | 33 30         | 11 24          |
| * Tripoli     | 32 54         | 13 11          |
| Magra         | 32 29         | 15 0           |
| C. Mensurato  | 32 24         | 15 39          |
| C. Lorat      | 31 0          | 16 30          |
| C. Studico    | 31 43         | 17 37          |
| Santores      | 30 17         | 18 40          |
| C. Linconta   | 30 57         | 18 16          |
| C. Sarabion   | 31 28         | 19 1           |
| Zoara         | 31 12         | 19 0           |
| C. Bengaza    | 32 28         | 20 2           |
| C. Razat      | 33 7          | 22 20          |
| Derne         | 32 59         | 22 21          |
| C. Razatin    | 32 45         | 22 57          |



TABLE XXIV. OF LATITUDES AND LONGITUDES.

|                                    | Lat.<br>D. M. | Long.<br>D. M. |                                                                | Lat.<br>D. M. | Long.<br>D. M. |
|------------------------------------|---------------|----------------|----------------------------------------------------------------|---------------|----------------|
| C. Luco                            | 32 15 N.      | 25 25 E.       | Planoso                                                        | 42 34 N.      | 9 45 E.        |
| C. Soliman                         | 31 40         | 25 45          | Capraia                                                        | 43 10         | 9 35           |
| P. Ramitan                         | 31 25         | 26 27          | Gorgona                                                        | 43 24         | 9 21           |
| C. Lagofego                        | 31 13         | 27 19          | Ponza                                                          | 42 32         | 9 55           |
| C. Capopero                        | 31 3          | 28 49          | Lustera                                                        | 38 53         | 13 35          |
| C. Rose                            | 31 0          | 29 40          | Strombolo                                                      | 38 57         | 15 52          |
| * Alexandria                       | 31 11         | 30 22          | Leuaze                                                         | 38 10         | 12 20          |
| C. Brule                           | 31 44         | 31 34          | Mareljmo                                                       | 38 0          | 12 11          |
| Domiatia                           | 31 36         | 32 1           | Faughana                                                       | 37 56         | 12 26          |
| Bereila                            | 31 20         | 32 47          | Sicily, W. Point                                               | 38 11         | 13 40          |
| C. Gallo                           | 31 34         | 33 55          | Ditto, S. ditto                                                | 36 45         | 15 36          |
| Jaffa                              | 32 5          | 35 10          | Messina in ditto                                               | 38 15         | 15 59          |
| M. Carmel                          | 32 50         | 35 16          | Pantelaria                                                     | 36 54         | 12 0           |
| C. Vardo                           | 34 18         | 35 57          | Linofa                                                         | 35 55         | 12 38          |
| Tripoly                            | 36 46         | 36 24          | Piduffa                                                        | 35 40         | 12 40          |
| Tortofa                            | 35 20         | 36 25          | Malta, N. Point                                                | 36 0          | 14 22          |
| C. Saudin                          | 36 0          | 36 0           | Ditto, S. ditto                                                | 35 39         | 14 35          |
| C. Canzin                          | 36 21         | 35 47          | * The Harbour in Malta                                         | 36 0          | 14 34          |
| * Alexandretta or Scan-            |               |                | Gozo, N. Point                                                 | 36 12         | 14 50          |
| deroon                             | 36 35         | 36 26          | Corfu, S. E. Point                                             | 39 31         | 20 50          |
| Aleppo                             | 35 45         | 37 26          | Fano, Entrance of the                                          |               |                |
| C. Urico                           | 36 35         | 34 20          | Gulf of Venice                                                 | 40 8          | 21 6           |
| P. Cavelero                        | 36 33         | 33 17          | Pelegofa                                                       | 42 14         | 16 30          |
| C. Dranmont                        | 36 23         | 32 7           | Piani                                                          | 42 9          | 16 13          |
| Satalia                            | 36 58         | 30 35          | Tremilli                                                       | 42 10         | 15 50          |
| C. Blane                           | 36 21         | 30 21          | Liffa                                                          | 42 47         | 16 27          |
| C. Seven Capes                     | 36 31         | 28 54          | Pomo                                                           | 43 2          | 15 55          |
| C. Baibe                           | 36 44         | 28 10          | Longa, S. E. Part                                              | 43 55         | 15 52          |
| C. Crio                            | 36 45         | 27 34          | Scio, S. Point                                                 | 38 14         | 26 32          |
| C. Petreia                         | 37 10         | 27 30          | Cerigo, S. Point                                               | 36 22         | 23 21          |
| C. St. Mary                        | 37 45         | 27 20          | Cerigotte                                                      | 35 55         | 24 43          |
| C. Blanc                           | 38 16         | 26 32          | Milo                                                           | 36 41         | 25 6           |
| * Smyrna                           | 38 28         | 27 26          | Mitelen, W. Point                                              | 39 15         | 27 12          |
| C. Baba                            | 39 24         | 26 20          | Goze                                                           | 35 2          | 24 5           |
| C. Janefari                        | 39 53         | 26 32          | S. W. Point                                                    | 35 17         | 23 36          |
| C. Capitani                        | 40 13         | 28 0           | Cape Spada                                                     | 35 45         | 24 18          |
| Prussias                           | 40 35         | 29 4           | S. E. Point,                                                   | 35 21         | 23 55          |
|                                    |               |                | N. E. Point,                                                   | 35 35         | 27 6           |
|                                    |               |                | Rhodes, S. E. Point                                            | 35 27         | 28 45          |
|                                    |               |                | Cyprus, W. Point                                               | 35 0          | 31 55          |
|                                    |               |                | E. Point                                                       | 35 40         | 35 0           |
|                                    |               |                | S. Point                                                       | 34 30         | 33 16          |
| <i>Islands within the Straits.</i> |               |                |                                                                |               |                |
| * Alboran                          | 36 N.         | 2 48 W.        | <i>The Coast of Africa from Cape<br/>Spartel to Cape Verd.</i> |               |                |
| Zaffarine Islands                  | 35 23         | 2 7 8          |                                                                |               |                |
| Formentera, W. Point               | 38 41         | 0 49 E.        | * Cape Spartel                                                 | 35 48 N.      | 5 47 W.        |
| Ditto, E. ditto                    | 38 39         | 1 10           | * Larash                                                       | 35 11         | 6 8            |
| Ivica, S. ditto                    | 38 48         | 0 51           | * New Sale                                                     | 32 35         | 6 38           |
| Ditto, N. E. ditto                 | 39 10         | 1 11           | * Mazagan                                                      | 33 15         | 8 11           |
| Salina                             | 38 50         | 0 40           | * Cape Blanco                                                  | 33 5          | 8 20           |
| Carbera, S. Point                  | 39 10         | 2 23           | * Cape Cantia                                                  | 32 35         | 9 0            |
| Majorca, S. Point                  | 39 18         | 2 30           | * Saffia Bay                                                   | 32 20         | 8 40           |
| Ditto, N. ditto                    | 40 45         | 2 40           | * Mogadore Island                                              | 31 27         | 9 25           |
| Ditto, W. ditto                    | 39 40         | 1 51           | * Cape Geer                                                    | 30 28         | 9 47           |
| Ditto, E. ditto                    | 39 42         | 3 2            | Santa Cruz                                                     | 30 29         | 9 34           |
| Minorca, S. ditto                  | 39 43         | 3 50           | Cape Nun                                                       | 28 40         | 11 10          |
| * Minorca, St. Philip's<br>Fort    | 39 51         | 3 54           | * Cape Bajador                                                 | 26 29         | 14 20          |
| Ditto, N. ditto Point              | 40 16         | 3 21           | * Cape das Barbas                                              | 23 15         | 16 34          |
| Sardinia, S. W. Point              | 39 4          | 8 18           | * Cape Blanco                                                  | 20 41         | 16 52          |
| Ditto, S. E. ditto                 | 39 0          | 9 54           | Arguin                                                         | 20 22         | 16 22          |
| Ditto, N. ditto                    | 41 15         | 8 55           | Cape Miric                                                     | 19 15         | 16 16          |
| Ditto, N. W. ditto                 | 40 57         | 8 2            | Portendic                                                      | 18 6          | 16 58          |
| Seneca, N. Point                   | 41 13         | 8 6            | Senegal Bar                                                    | 15 51         | 16 9           |
| St. Pelem                          | 39 0          | 8 5            | * Cape Verd                                                    | 14 46         | 17 47          |
| Tovo                               | 38 40         | 8 20           |                                                                |               |                |
| Galite                             | 37 50         | 8 55           |                                                                |               |                |
| Elba                               | 42 48         | 9 50           |                                                                |               |                |

TABLE XXIV. OF LATITUDES AND LONGITUDES.

*The Western Isles.*

|                         | Lat.<br>D. M. | Long.<br>D. M. |
|-------------------------|---------------|----------------|
| * Corvo                 | 39 42 N.      | 31 0 W.        |
| * Flores                | 39 34         | 29 54          |
| * Fayal, the Town       | 38 33         | 28 37          |
| * Pico                  | 38 29         | 28 20          |
| Tercera                 | 38 54         | 28 15          |
| St. George              | 38 39         | 27 55          |
| Graciosa                | 39 2          | 28 4           |
| * St. Michael, E. Point | 37 47         | 25 48          |
| Ditto, W. Point         | 37 50         | 26 48          |
| * St. Mary              | 37 0          | 25 6           |

*The Madeiras.*

|                              |                    |          |
|------------------------------|--------------------|----------|
| * Porto Santo                | 32 58 N.           | 16 20 W. |
| Rock E. of ditto under water | 33 30              | 16 2     |
| Madeira, East P.             | 32 50              | 16 46    |
| Ditto, West P.               | 32 30              | 17 26    |
| * Funchal                    | 32 38              | 17 5     |
| The Salvages Islands         | 30 8 $\frac{1}{2}$ | 16 4     |

*The Canaries.*

|                         |          |          |
|-------------------------|----------|----------|
| * Manzarote, North P.   | 29 25 N. | 13 26 W. |
| * Ditto, South P.       | 28 51    | 13 41    |
| Forteventura, West P.   | 28 4     | 14 26    |
| Ditto, East P.          | 28 40    | 13 40    |
| * Canaria, N. E. P.     | 28 13    | 15 33    |
| * Ditto, South P.       | 27 42    | 15 54    |
| * The Peak of Teneriffe | 28 13    | 16 26    |
| * Ditto, North P.       | 28 39    | 16 0     |
| * Orotavia in ditto     | 28 23    | 16 30    |
| Santa Cruz in ditto     | 28 27    | 16 18    |
| Palma, North P.         | 28 36    | 17 32    |
| Tazicote in ditto       | 28 6     | 17 3     |
| Ditto, South P.         | 28 18    | 17 37    |
| Gomera, at the Port     | 28 6     | 17 4     |
| * Ferro, the Town       | 27 47    | 17 40    |
| * Ditto, East P.        | 27 50    | 17 37    |
| Ditto, West P.          | 27 46    | 17 52    |

*Cape Verd Islands.*

|                    |         |          |
|--------------------|---------|----------|
| St. Anthony        | 17 9 N. | 24 48 W. |
| St. Vincent        | 16 50   | 24 36    |
| St. Lucia          | 16 44   | 24 31    |
| St. Nicholas       | 16 32   | 24 16    |
| * Sal              | 16 38   | 22 50    |
| * Bonavista        | 16 6    | 22 41    |
| * Mayo             | 15 10   | 23 0     |
| St. Jago, North P. | 14 54   | 23 27    |
| Ditto, South P.    | 14 17   | 23 25    |
| Brava              | 14 50   | 24 39    |
| * Fogo             | 14 57   | 24 22    |

*From Cape Verd to the Cape of Good Hope.*

|                                             | Lat.<br>D. M. | Long.<br>D. M. |
|---------------------------------------------|---------------|----------------|
| * Cape de Verde                             | 14 46 N.      | 17 47 W.       |
| * Goree Isle                                | 14 36         | 17 37          |
| Cape Naze                                   | 14 24         | 17 18          |
| Cape St. Mary, Entrance to the River Gambia | 13 17         | 16 56          |
| Cape Roxo                                   | 12 23         | 17 10          |
| Cape Vergue                                 | 9 52          | 14 56          |
| Delos Isles                                 | 9 29          | 14 7           |
| * Cape Sierra Leon                          | 8 29          | 13 48          |
| * Cape Ann                                  | 7 7           | 13 27          |
| * Cape Mount                                | 6 46          | 11 42          |
| * Cape Mezurado                             | 6 16          | 11 17          |
| Cape Baxos                                  | 5 28          | 10 7           |
| Seistos River                               | 5 27          | 9 47           |
| Cape Formosa                                | 5 8           | 9 39           |
| * Cape Palmas                               | 4 26          | 8 15           |
| St. Andrew's River                          | 4 58          | 6 30           |
| Cape Maho                                   | 5 12          | 5 12           |
| * Cape Appollonia                           | 4 59          | 3 11           |
| * Axim                                      | 4 52          | 2 36           |
| * Cape Three Points                         | 4 40          | 2 38           |
| * Dix Cove                                  | 4 48          | 2 22           |
| * Sakondee                                  | 5 0           | 1 59           |
| * Elmina                                    | 5 10          | 1 40           |
| * Cape Corfe Castle                         | 5 12          | 1 28           |
| * Devil's Hill                              | 5 24          | 0 50 E.        |
| * Anamaboe Fort                             | 5 10          | 1 7            |
| * Acra                                      | 5 30          | 0 16           |
| * Tibberacoe                                | 5 53          | 1 23           |
| River Volta                                 | 5 53          | 1 25           |
| Cape St. Paul                               | 5 52          | 1 40           |
| Whidah                                      | 6 25          | 3 13           |
| Formosa River                               | 5 33          | 6 10           |
| Cape Formosa                                | 4 30          | 6 46           |
| New Callabar River                          | 4 23          | 8 0            |
| Cameron River                               | 3 20          | 10 0           |
| Cape St. John                               | 1 15          | 9 23           |
| Gabon River                                 | 0 0           | 9 23           |
| C. de Lopas Gonfalvez                       | 0 47 S.       | 9 12           |
| Seisto River                                | 2 16          | 9 35           |
| Alvary Bay                                  | 3 27          | 10 40          |
| Congo River                                 | 4 35          | 11 5           |
| Ambris River                                | 6 45          | 12 0           |
| Cape Ledo                                   | 9 50          | 12 3           |
| St. Philip de Benguela                      | 12 18         | 12 35          |
| * Cape Negro, appears like black hommocks   | 16 27         | 12 44          |
| * Tiger's Island                            | 16 30         | 12 0           |
| Cape Frio                                   | 18 40         | 13 42          |
| * Elizabeth's Bay                           | 26 12         | 15 30          |
| Cape Rostro de Pedro                        | 23 0          | 14 0           |
| * Angra Pequena                             | 26 35         | 15 40          |
| Cape das Voltas                             | 29 0          | 16 45          |
| * Walwick Bay, N. W. Point                  | 23 0          | 14 0           |
| Cape Descada                                | 32 20         | 15 24          |
| * St. Helen's Bay, C. St. Martin's          | 32 45         | 17 45          |
| * Saldanah Bay                              | 33 8          | 18 0           |
| * Cape of Good Hope                         | 34 29         | 18 29          |

TABLE XXIV. OF LATITUDES AND LONGITUDES.

*Islands between Cape Verd, the Cape  
of Good Hope, and Cape Horn.*

|                                   | Lat.<br>D. M. | Long.<br>D. M. |
|-----------------------------------|---------------|----------------|
| St. Paul's                        | 0 54N.        | 26 40W         |
| * Ferdinand Noronha               | 3 56S.        | 32 32          |
| St. Matthew                       | 1 33          | 7 30           |
| Fernand de Po, N. P.              | 3 23N.        | 8 50E.         |
| Princes I.                        | 1 44          | 8 0            |
| * St. Thomas, Man of<br>War's Bay | 0 27          | 7 0            |
| * Ditto, South P.                 | 0 5           | 6 50           |
| * Annabona                        | 1 28S.        | 5 52           |
| * Trinidad                        | 20 15         | 30 30W         |
| * Ascension                       | 7 56          | 14 16          |
| * St. Hellena, James<br>Town      | 15 55         | 5 46           |
| Saxemburgh                        | 30 41         | 19 15          |
| * Tristau da Cunha                | 37 10         | 13 20          |
| Diego Alvarez                     | 39 20         | 11 2           |
| * Gough's Island                  | 40 3          | 2 30           |
| Falkland I. N. E. P.              | 51 50         | 63 30          |
| Ditto, S. W. Point                | 51 0          | 66 5           |
| * Island of Georgia               | 54 30         | 37 30          |

*From the Cape of Good Hope to  
Canton.*

|                                                  |         |          |
|--------------------------------------------------|---------|----------|
| * Cape of Good Hope                              | 34 29S. | 18 29 E. |
| Falfe Cape                                       | 34 16   | 18 50    |
| Cape Agullias                                    | 34 44   | 20 15    |
| * Falfe Bay                                      | 34 10   | 18 39    |
| Bay St. Braze                                    | 34 28   | 21 59    |
| Cape Talbrado                                    | 33 27   | 24 7     |
| * Algoa Bay                                      | 33 30   | 26 35    |
| Cape Delgado, Musc B.                            | 33 38   | 24 10    |
| * First P. of Natal                              | 32 11   | 28 51 E. |
| * Middle P. Natal                                | 30 45   | 30 20    |
| Port Natal                                       | 29 50   | 30 57    |
| Smoaky Cape                                      | 27 7    | 32 15    |
| Cape St. Mary, Entrance<br>of Delagoa Bay        | 25 51   | 33 16    |
| Cape Coriantes                                   | 23 37   | 36 35    |
| Cape St. Sebastian                               | 21 35   | 36 25    |
| Sofala                                           | 20 15   | 35 32    |
| Angoxa                                           | 16 11   | 39 27    |
| Judda                                            | 21 29   | 39 26    |
| * Mozenbique                                     | 14 56   | 40 29    |
| Cape Delgado                                     | 10 6    | 41 15    |
| Giuloa                                           | 8 41    | 39 40    |
| Mombas                                           | 3 34    | 41 30    |
| Melinda                                          | 2 45    | 41 47    |
| * Magadosha                                      | 2 20N.  | 46 25    |
| Cape Bassas                                      | 4 50    | 49 2     |
| * Cape Orfui                                     | 10 27   | 51 38    |
| * Cape Guardafui                                 | 11 47   | 51 35    |
| * Cape Babelmandel, En-<br>trance of the Red Sea | 12 38   | 43 47    |
| * Cape Fartash                                   | 15 29   | 52 5     |
| * Cape Aden                                      | 12 45   | 45 17    |
| Cape Morebet                                     | 17 16   | 54 19    |
| * Socotra I. East Point                          | 12 18   | 54 23    |
| Ditto, West Point                                | 12 45   | 53 2     |
| * Cape Pedro                                     | 17 54   | 55 27    |
| * Moka in the Red Sea                            | 13 17   | 43 17    |

|                                                 | Lat.<br>D. M. | Long.<br>D. M. |
|-------------------------------------------------|---------------|----------------|
| Cape Ifoclette                                  | 19 4N.        | 57 18E.        |
| Great Mazeira I.                                | 20 15         | 58 31          |
| Cape Roselgate                                  | 22 36         | 59 54          |
| Muscat                                          | 23 30         | 58 16          |
| Cape Jask                                       | 25 57         | 57 15          |
| C. Musfeldon, Entrance<br>to the Gulf of Persia | 26 17         | 56 17          |
| Cape Birdistan                                  | 28 0          | 51 8           |
| Gambaroon                                       | 27 18         | 56 6           |
| Cape Monze                                      | 25 0          | 66 18          |
| * Bassora                                       | 30 31         | 47 32          |
| * Point Gigat                                   | 23 30         | 63 35          |
| Diau Point                                      | 20 44         | 69 50          |
| Cambaye                                         | 23 36         | 72 17          |
| Surat                                           | 21 10         | 72 26          |
| Cape St. John                                   | 20 6          | 72 34          |
| * Bombay                                        | 18 57         | 72 43          |
| Dabul                                           | 18 0          | 73 29          |
| * Goa                                           | 15 31         | 73 55          |
| Barcelore                                       | 13 53         | 75 2           |
| Mangalore                                       | 13 0          | 75 35          |
| Mount Dilly                                     | 12 5          | 75 35          |
| * Cochin                                        | 9 53          | 76 27          |
| * Cape Comorin                                  | 7 57          | 77 32          |
| Dondra Head, South P.<br>of Ceylon              | 5 47          | 81 2           |
| * Trincomalee                                   | 8 35          | 81 27          |
| Point Pedro                                     | 9 57          | 80 39          |
| Point Calymere                                  | 10 13         | 79 54          |
| * Negapatnam                                    | 10 32         | 79 53          |
| * Pondicherry                                   | 11 42         | 79 59          |
| * Fort St. David's                              | 11 29         | 79 54          |
| * Madras                                        | 13 5          | 80 35          |
| Point Divy                                      | 16 2          | 81 29          |
| * Masulipatnam                                  | 16 16         | 81 24          |
| * Coringa Bay                                   | 16 58         | 82 30          |
| * Point Gordeware                               | 16 45         | 82 37          |
| * Visagapatam                                   | 17 46         | 83 35          |
| * Gamjam                                        | 19 25         | 85 7           |
| * Jagerhaut Pagoda                              | 19 48         | 85 57          |
| * Black Pagoda                                  | 19 51         | 86 10          |
| Falfe Point                                     | 20 17         | 86 51          |
| * Point Palmyras                                | 20 44         | 87 10          |
| * Kadgiree                                      | 21 48         | 88 56          |
| * Balafore                                      | 21 21         | 87 21          |
| * Ingellee                                      | 21 50         | 88 11          |
| * Calcutta                                      | 22 34         | 88 33          |
| * Chandernagor                                  | 22 51         | 88 35          |
| * Islamabad                                     | 22 20         | 91 52          |
| Aracan River                                    | 20 17         | 91 0           |
| Cheduba Isle                                    | 18 45         | 93 37          |
| * C. Negrais                                    | 16 8          | 94 9           |
| * Gulf of Martaban                              | 15 37         | 96 30          |
| * Tavay Point                                   | 13 37         | 97 44          |
| * Junkfeylon                                    | 8 15          | 98 2           |
| * Malacca                                       | 2 12          | 102 11         |
| * Cape Romania                                  | 1 15          | 104 5          |
| * Siam, in the Gulf of<br>Siam                  | 14 18         | 100 55         |
| * Cambaja Point                                 | 8 45          | 103 43         |
| Avarella Point                                  | 12 54         | 107 50         |
| * Pulo Canton                                   | 15 15         | 107 15         |
| C. Nord or Turon                                | 16 4          | 106 30         |
| * Macao                                         | 22 13         | 113 52         |
| * Canton                                        | 23 8          | 113 8          |



TABLE XXIV. OF LATITUDES AND LONGITUDES.

*Islands lying between the Cape of Good Hope and Cape Camoron.*

|                                 | Lat.     | Long.    |
|---------------------------------|----------|----------|
|                                 | D. M.    | D. M.    |
| St. Paul's Island               | 37 31 S. | 77 56 E. |
| Amsterdam                       | 38 15    | 78 0     |
| * South P. Cape                 |          |          |
| St. Mary's                      | 25 33    | 44 55    |
| North P. C. Am-<br>bro or Natal | 12 2     | 50 19    |
| * St. Augustin's B.             | 23 35    | 43 30    |
| C. St. Vincent                  | 21 46    | 43 37    |
| C. St. Andrew's                 | 16 6     | 45 32    |
| C. St. Sebastian                | 12 30    | 49 44    |
| Bay Antongil                    | 16 0     | 50 38    |
| I. St. Mary                     | 16 54    | 50 36    |
| * Foul Point                    | 17 41    | 49 59    |
| * Fort Dauphin                  | 25 0     | 47 5     |
| Bassas de India                 | 22 20    | 41 39    |
| Europa Rocks                    | 21 30    | 40 17    |
| Juan de Nova                    | 17 15    | 43 7     |
| Suffex Rocks                    | 21 29    | 42 26    |
| Bazaruto Islands                | 21 16    | 36 30    |
| English Bank                    | 17 30    | 39 27    |
| Chesterfield Shoal              | 16 17    | 44 0     |
| * Mayotto I.                    | 12 47    | 45 30    |
| * Mohilla I.                    | 12 30    | 43 55    |
| * Johanna I.                    | 12 15    | 44 35    |
| * Comoro                        | 11 32    | 43 30    |
| Portuguese Shoals               | 12 33 S. | 46 55 E. |
| John Martin's I.                | 10 9     | 43 15    |
| Aldabra Islands                 | 9 40     | 46 45    |
| Assumption I.                   | 9 46     | 47 37    |
| Cosmoledo I.                    | 9 46     | 48 38    |
| St. Peter's I.                  | 9 34     | 50 47    |
| Natal I.                        | 8 30     | 47 15    |
| Sandy I.                        | 9 16     | 48 12    |
| Zanzibar I.                     | 6 19     | 40 45    |
| Amirante I. N. W. P.            | 5 10     | 53 45    |
| S. E. P.                        | 6 39     | 55 0     |
| Mahe I. N. W. P.                | 5 50 N.  | 54 5     |
| S. E. P.                        | 5 20 S.  | 56 30    |
| * Isle Bourbon                  | 20 52    | 55 36    |
| * Mauritius                     | 20 10    | 57 35    |
| * Diego Rais or Ro-<br>drigues  | 19 40    | 63 10    |
| * St. Brandon                   | 16 34    | 62 50    |
| Nazareth Bank, S. W.<br>Point   | 16 45    | 60 0     |
| N. E. Point                     | 13 35    | 61 44    |
| Sandy Island                    | 15 10    | 55 5     |
| * South Roquepiz                | 10 30    | 64 32    |
| John de Nova                    | 10 15    | 53 30    |
| Providence I.                   | 9 15     | 53 32    |
| St. Francis Isles               | 7 10     | 56 30    |
| Peros Banhos                    | 5 30     | 72 20    |
| * Diego Garcia                  | 7 30     | 72 35    |
| Candu Isles                     | 6 0 N.   | 76 35    |
| Adu Isles                       | 5 30     | 76 20    |
| Maldiva Isles, S. E. P.         | 0 40 S.  | 74 55    |
| N. W. P.                        | 7 15 N.  | 73 40    |
| Malique Islands                 | 8 15     | 73 29    |
| Laccadive Isles, S. E. P.       | 10 0     | 72 45    |
| N. W. P.                        | 12 36    | 72 25    |

*Isles East of Cape Comorin.*

|                                                                                                                                         | Lat.    | Long.   |
|-----------------------------------------------------------------------------------------------------------------------------------------|---------|---------|
|                                                                                                                                         | D. M.   | D. M.   |
| * Ceylon, S. Point                                                                                                                      | 5 47 N. | 81 2 E. |
| * N. Point                                                                                                                              | 9 57    | 80 39   |
| * Trincomalee in ditto                                                                                                                  | 8 35    | 81 27   |
| Bale of Cotton Rock                                                                                                                     | 5 28    | 86 15   |
| Preparis I.                                                                                                                             | 14 50   | 93 35   |
| Cocos I. North P.                                                                                                                       | 14 21   | 93 19   |
| * Great Andaman I.                                                                                                                      |         |         |
| North P.                                                                                                                                | 13 30   | 92 30   |
| South P.                                                                                                                                | 11 21   | 92 35   |
| Little Andaman, S. P.                                                                                                                   | 10 15   | 92 45   |
| Nicobar Isles, N. P.                                                                                                                    | 9 25    | 93 7    |
| South P.                                                                                                                                | 6 51    | 94 17   |
| Seyers I.                                                                                                                               | 7 35    | 95 30   |
| Log I.                                                                                                                                  | 2 30    | 95 45   |
| Pooloo Nyas                                                                                                                             | 0 57    | 97 2    |
| Po Mintoon                                                                                                                              | 0 25 S. | 97 45   |
| Good Fortune I. S. P.                                                                                                                   | 1 57    | 99 49   |
| Engona                                                                                                                                  | 5 20    | 101 54  |
| Boggy or Nallau, S. P.                                                                                                                  | 3 15    | 100 25  |
| Trompeuse                                                                                                                               | 5 33    | 102 30  |
| * Prince's I. Straits of<br>Sunda                                                                                                       | 6 24    | 104 48  |
| Bearings of a Rock on<br>which the Indostan<br>struck in the Straits<br>of Sunda.                                                       |         |         |
| Zeeclip West 5° North<br>Pk. on Crocatoe S. 15° W.                                                                                      |         |         |
| Peak on Tamarind I.<br>N. 6° W.                                                                                                         |         |         |
| Captain M'Intosh rowed<br>round the Rock in a<br>Circle of ten Fathoms<br>and the Boat was ne-<br>ver in less than ten<br>Fathom Water. |         |         |
| * Christmas I.                                                                                                                          | 10 30   | 104 27  |
| Coco Island                                                                                                                             | 21 45   | 98 30   |
| * Java Head, or W. P.                                                                                                                   | 6 45    | 104 55  |
| * East P.                                                                                                                               | 8 37    | 104 37  |
| North Island                                                                                                                            | 5 41    | 105 50  |
| Peak on Crocatoe I.                                                                                                                     | 6 8     | 105 14  |
| Peak on Tamarin I.                                                                                                                      | 6 54    | 105 18  |
| Zeeclip                                                                                                                                 | 6 50    | 105 12  |
| * Batavia in ditto                                                                                                                      | 6 10    | 106 57  |
| * Bally Straits, South<br>Entrance                                                                                                      | 8 45    | 114 47  |
| * Bally I. South Point                                                                                                                  | 8 56    | 115 23  |
| Lombok Straits                                                                                                                          | 9 10    | 115 57  |
| Straits of Mals                                                                                                                         | 9 0     | 116 50  |
| Straits of Sapy                                                                                                                         | 8 30    | 119 30  |
| Sandal Wood I.                                                                                                                          | 9 45    | 120 0   |
| Rotto I.                                                                                                                                | 11 15   | 123 7   |
| Timor I. West Point                                                                                                                     | 10 15   | 123 43  |
| * Pulo Runda                                                                                                                            | 5 59    | 95 39   |
| * Pulo Way                                                                                                                              | 5 49    | 95 33   |
| * Pulo Braille                                                                                                                          | 5 38    | 95 21   |
| * Pumatra, West Point                                                                                                                   | 5 25 N. | 95 32   |
| * Achen, in ditto                                                                                                                       | 5 22    | 95 40   |
| * Bencoolen, in ditto                                                                                                                   | 3 49 S. | 102 6   |
| * East Point                                                                                                                            | 5 53    | 104 7   |

TABLE XXIV. OF LATITUDES AND LONGITUDES.

| <i>Islands in the China Seas to the Eastward of Java.</i>                                                                                          |          |           | Lat.  | Long. |
|----------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------|-------|-------|
|                                                                                                                                                    | D. M.    | D. M.     | D. M. | D. M. |
| * Banca, North P.                                                                                                                                  | 1 33 S.  | 116 0 E.  |       |       |
| South P.                                                                                                                                           | 3 4      | 106 17    |       |       |
| * Lucepara, S. Entrance to the Straits of Banca                                                                                                    | 3 12     | 106 10    |       |       |
| Monopin Hill                                                                                                                                       | 2 0      | 105 8     |       |       |
| Billiton, S. E. Point                                                                                                                              | 3 6      | 108 15    |       |       |
| Bintang, E. Entrance to the Straits of Singapore                                                                                                   | 0 18     | 105 15    |       |       |
| Spirit Island                                                                                                                                      | 0 7 N.   | 106 30    |       |       |
| St. Julian's Island                                                                                                                                | 0 45     | 106 38    |       |       |
| Timelan Island                                                                                                                                     | 1 0      | 107 15    |       |       |
| Victory Island                                                                                                                                     | 1 28     | 105 55    |       |       |
| Wood I.                                                                                                                                            | 1 34     | 105 47    |       |       |
| Saddle I.                                                                                                                                          | 2 17     | 105 44    |       |       |
| Anambas I.                                                                                                                                         | 2 47     | 106 15    |       |       |
| Natunas I.                                                                                                                                         | 4 5      | 108 10    |       |       |
| * Pulo Tinoy I.                                                                                                                                    | 2 30     | 105 52    |       |       |
| * Pulo Aroe I.                                                                                                                                     | 2 30     | 104 42    |       |       |
| * Pulo Timon I. S. P.                                                                                                                              | 2 49     | 104 24    |       |       |
| * Pulo Brata                                                                                                                                       | 4 45     | 103 30    |       |       |
| Pulo Lazen                                                                                                                                         | 7 17     | 102 30    |       |       |
| Ridang I.                                                                                                                                          | 6 20     | 102 37    |       |       |
| * Pulo Uby                                                                                                                                         | 8 30     | 103 45    |       |       |
| * Pulo Way                                                                                                                                         | 10 0     | 102 34    |       |       |
| Two Brothers                                                                                                                                       | 8 32     | 105 37    |       |       |
| * Pulo Condor                                                                                                                                      | 8 41     | 106 10    |       |       |
| * Pulo Sapata                                                                                                                                      | 10 4     | 108 42    |       |       |
| Elephant                                                                                                                                           | 11 0     | 113 10    |       |       |
| Pitt's I.                                                                                                                                          | 10 55    | 114 35    |       |       |
| South Sea Castle I.                                                                                                                                | 11 30    | 112 17    |       |       |
| Paracels I. North P.                                                                                                                               | 16 30    | 110 0     |       |       |
| South P.                                                                                                                                           | 11 37    | 109 30    |       |       |
| Macclesfield Bank, N. Point                                                                                                                        | 16 6     | 114 10    |       |       |
| South Point                                                                                                                                        | 15 15    | 114 20    |       |       |
| Scarborough Rocks                                                                                                                                  | 15 0     | 117 12    |       |       |
| Hainan, North Point                                                                                                                                | 20 2     | 110 15    |       |       |
| South Point                                                                                                                                        | 18 12    | 109 20    |       |       |
| * Formosa, South P.                                                                                                                                | 27 47    | 120 52    |       |       |
| Pratas Rocks                                                                                                                                       | 20 30    | 116 15    |       |       |
| Triangles Rocks, N. P.                                                                                                                             | 17 0     | 111 0     |       |       |
| S. P.                                                                                                                                              | 16 0     | 111 32    |       |       |
| * Borneo, S. W. Point                                                                                                                              | 2 45 S.  | 109 28    |       |       |
| * S. E. Point                                                                                                                                      | 4 15     | 114 25    |       |       |
| * W. Point                                                                                                                                         | 0 0      | 108 45    |       |       |
| * E. Point                                                                                                                                         | 5 15 N.  | 118 50    |       |       |
| * N. Point                                                                                                                                         | 7 0      | 116 45    |       |       |
| * Balambangan, Entrance to the Sooloo Sea                                                                                                          | 7 30     | 117 2     |       |       |
| Banguay                                                                                                                                            | 7 17     | 117 30    |       |       |
| Palawan, S. Point                                                                                                                                  | 8 28     | 117 30    |       |       |
| N. Point                                                                                                                                           | 11 20    | 119 46    |       |       |
| * Sooloo I. E. Point                                                                                                                               | 5 57     | 121 21    |       |       |
| Celibes, S. Point                                                                                                                                  | 5 42 S.  | 120 6     |       |       |
| N. Point                                                                                                                                           | 2 0 N.   | 124 0     |       |       |
| Luconia, N. Point                                                                                                                                  | 18 45    | 120 45    |       |       |
| * Manilla in Luconia                                                                                                                               | 14 36    | 120 59    |       |       |
| * Karkalang I. S. P.                                                                                                                               | 3 52     | 126 14    |       |       |
| N. E. P.                                                                                                                                           | 4 29     | 126 20    |       |       |
| * Moratay I.                                                                                                                                       | 2 28     | 127 30    |       |       |
| * Gilolo I. N. Point                                                                                                                               | 2 17 N.  | 127 30 E. |       |       |
| * W. Point                                                                                                                                         | 1 8      | 127 1     |       |       |
| * Heri I.                                                                                                                                          | 0 59     | 126 54    |       |       |
| * Ternate I.                                                                                                                                       | 0 57     | 126 53    |       |       |
| * Mariene I.                                                                                                                                       | 0 21 S.  | 126 40    |       |       |
| * Sutta Mangal I.                                                                                                                                  | 1 48     | 126 17    |       |       |
| * Burro I. West P.                                                                                                                                 | 3 3      | 125 43    |       |       |
| * Sutta Bassie I.                                                                                                                                  | 2 36     | 125 41    |       |       |
| * N. end of a dangerous Shoal off Bouton I.                                                                                                        | 5 25     | 122 8     |       |       |
| * Bouton I. S. P.                                                                                                                                  | 5 42     | 121 11    |       |       |
| * Toucca Bassie I.                                                                                                                                 | 5 35     | 123 15    |       |       |
| * Balataya I.                                                                                                                                      | 5 55     | 122 37    |       |       |
| * Cambona I.                                                                                                                                       | 5 29     | 121 26    |       |       |
| * Salayer Straits                                                                                                                                  | 5 44     | 120 6     |       |       |
| * Celibes I. S. P.                                                                                                                                 | 5 42     | 120 6     |       |       |
| N. P.                                                                                                                                              |          |           |       |       |
| N. W. P.                                                                                                                                           |          |           |       |       |
| Tonyn I.                                                                                                                                           | 5 27     | 118 2     |       |       |
| Lucifiva I.                                                                                                                                        |          |           |       |       |
| Paternosters in the Straits of Macassar                                                                                                            |          |           |       |       |
| Pulo Laut, S. P.                                                                                                                                   |          |           |       |       |
| * Great Solombo                                                                                                                                    | 5 28     | 113 8     |       |       |
| * Lubeck I.                                                                                                                                        | 5 47     | 112 12    |       |       |
| * Carimon Java I.                                                                                                                                  | 5 48     | 110 10    |       |       |
| Pulo Rachel I.                                                                                                                                     | 5 53     | 108 3     |       |       |
| NOTE. In these Seas there are many thousand Islands, so that it would be of no Use to lay them down here, Recourie must be had to the best Charts, |          |           |       |       |
| <i>New Holland.</i>                                                                                                                                |          |           |       |       |
| S. W. Cape                                                                                                                                         | 43 42 S. | 146 5 E.  |       |       |
| S. E. Cape                                                                                                                                         | 43 46    | 147 5     |       |       |
| * St. Maria's Isles                                                                                                                                | 43 20    | 148 10    |       |       |
| * St. Patrick's Head                                                                                                                               | 41 44    | 148 20    |       |       |
| * Cape Howe                                                                                                                                        | 37 24    | 149 54    |       |       |
| * Cape Dromedary                                                                                                                                   | 36 21    | 150 4     |       |       |
| * Botany Bay                                                                                                                                       | 34 0     | 151 20    |       |       |
| * Port Jackson                                                                                                                                     | 33 47    | 151 21    |       |       |
| * Cape Hawke                                                                                                                                       | 32 13    | 152 28    |       |       |
| * Smoky Cape                                                                                                                                       | 30 49    | 153 7     |       |       |
| * Cape Danger                                                                                                                                      | 28 7     | 152 28    |       |       |
| * Cape Morton                                                                                                                                      | 26 57    | 153 22    |       |       |
| * Sandy Cape                                                                                                                                       | 24 45    | 153 2     |       |       |
| * Keppel Bay                                                                                                                                       | 23 30    | 150 40    |       |       |
| * Cumberland I.                                                                                                                                    | 20 30    | 148 45    |       |       |
| * Cape Cleveland                                                                                                                                   | 19 10    | 148 5     |       |       |
| * Cape Flattery                                                                                                                                    | 14 53    | 145 10    |       |       |
| * Cape Conway                                                                                                                                      | 20 41    | 148 30    |       |       |
| * Cape York                                                                                                                                        | 10 44    | 141 37    |       |       |
| Van Diemen's Bay                                                                                                                                   | 10 30    | 150 15    |       |       |
| <i>New Guinea.</i>                                                                                                                                 |          |           |       |       |
| * Cape False                                                                                                                                       | 8 40 S.  | 156 30 E. |       |       |
| East Point                                                                                                                                         | 6 20     | 148 0     |       |       |
| * Louisiade Isles, E. P.                                                                                                                           | 10 35    | 154 0     |       |       |
| West Point                                                                                                                                         | 8 30     | 148 30    |       |       |
| * New Britain, East P.                                                                                                                             | 4 53     | 153 9     |       |       |
| West Point                                                                                                                                         | 6 0      | 149 20    |       |       |
| * New Ireland, East P.                                                                                                                             | 5 0      | 152 30    |       |       |
| West Point                                                                                                                                         | 2 20     | 148 20    |       |       |

TABLE XXIV. OF LATITUDES AND LONGITUDES.

*Rocks and Shoals lying West of New Holland.*

|                    | Lat.<br>D. M. | Long.<br>D. M. |
|--------------------|---------------|----------------|
| A Rock above Water | 28 17 S.      | 98 30 E.       |
| Cloats Islands     | 21 45         | 93 27          |
| Tryal Rocks        | 20 40         | 104 30         |
| Rosemary I.        | 20 30         | 110 45         |
| Abrolhos Shoals    | 28 30         | 111 45         |
| Kerguelen's Land   | 48 41         | 96 4           |

*Islands in the Pacific Ocean, lying between New Holland and Cape Horn.*

|                                     |          |           |
|-------------------------------------|----------|-----------|
| Formosa, South P.                   | 22 5N    | 120 50 E. |
| North P.                            | 25 15    | 122 13    |
| * Tayoan in Formosa                 | 22 40    | 120 20    |
| Great Liqueo, S. P.                 | 25 15    | 128 30    |
| North P.                            | 28 0     | 128 30    |
| Xuno I. South P.                    | 31 30    | 131 50    |
| North P.                            | 34 45    | 131 30    |
| Nippon, South P.                    | 33 30    | 135 0     |
| North P.                            | 41 0     | 142 0     |
| Matoofmaee                          | 42 30    | 140 30    |
| * Kamtschatka on the Main, South P. | 51 0     | 156 30    |
| Beering's I. South P.               | 54 0     | 161 30    |
| Ladrone Isles, Northernmost         | 21 0     | 114 6     |
| Southernmost                        | 8 0      | 114 6     |
| * Pescadore Isles                   | 10 30    | 164 0     |
| Huahige I.                          | 16 44 S. | 151 0W    |
| St. Bartholemi                      | 14 20N.  | 156 30    |
| I. St. Pierre                       | 11 0     | 198 45    |
| Sandwich Isles                      | 17 41 S. | 168 39 E. |
| Northernmost                        | 22 0     | 159 30W   |
| * Owhyhee, South P.                 | 20 0     | 155 30    |
| * Queen Charlotte I.                | 19 18    | 138 4     |
| * New Hebrides, Quiros C.           | 14 56    | 167 26 E. |
| Northernmost                        | 14 30    | 156 45    |
| Southernmost                        | 20 30    | 169 30    |
| * Ballabea I.                       | 20 7     | 164 28    |
| * New Calédonia, Pud-gona           | 20 18    | 164 47    |
| * C. Colenet                        | 20 30    | 165 2     |
| * Charlotte's Foreland              | 22 15    | 167 20    |
| North P.                            | 20 0     | 158 30    |
| * C. Coronation                     | 22 5     | 167 14    |
| * Friendly Isles, Northernmost      | 49 30    | 174 15W   |
| Southernmost                        | 21 30    | 175 10    |
| * Society Isles, N.W. End           | 17 30    | 152 0     |
| * Otaheite, Oaitipeha               | 17 46    | 149 8     |
| * Hood's I.                         | 9 26     | 138 46    |
| New Zealand.                        |          |           |
| * Dusky Bay                         | 45 47    | 166 24 E. |
| * Palliser's C.                     | 41 38    | 175 24    |
| * C. Farewell                       | 40 37    | 172 47    |
| * Turnagain C.                      | 40 26    | 178 3     |
| * North C.                          | 34 10    | 167 10    |
| * South C.                          | 47 20    | 167 30    |

|                        | Lat.<br>D. M. | Long.<br>D. M. |
|------------------------|---------------|----------------|
| * Sandwich Land, N. P. | 57 30 S.      | 27 30 W        |
| * South ditto          | 60 0          | 27 27          |

*South Georgia.*

|                   |       |       |
|-------------------|-------|-------|
| C. Buller         | 53 58 | 37 40 |
| C. Charlotte      | 54 32 | 36 11 |
| C. Disappointment | 54 58 | 36 15 |
| C. George         | 54 17 | 36 32 |
| C. North          | 54 4  | 38 15 |
| Sandwich Bay      | 54 42 | 36 12 |
| Saunders Island   | 54 6  | 36 58 |
| Wallis's Isles    | 54 0  | 38 29 |

*The Coast of Iceland.*

|              |         |        |
|--------------|---------|--------|
| Reiknefs C.  | 63 55N. | 22 40W |
| Westman's I. | 63 2    | 21 4   |
| Palrixfiord  | 55 36   | 24 4   |
| * Straumnefs | 65 40   | 24 26  |
| North Gape   | 66 34   | 23 5   |
| Grims I.     | 67 0    | 21 41  |
| * Rikefiord  | 67 9    | 17 30  |
| Long Nose    | 66 45   | 12 14  |
| Balanefs     | 66 2    | 12 16  |
| Enchufion I. | 65 0    | 10 0   |
| Engelhoast   | 64 32   | 12 14  |
| Wreeland I.  | 64 5    | 13 14  |
| C. Hekla     | 63 22   | 16 49  |

*The Coast of Greenland.*

|                      |         |       |
|----------------------|---------|-------|
| * John or Manen's I. | 71 10N. | 9 41W |
| Gael Hamkes Bay      | 75 0    | 6 43  |
| Bontekoe I.          | 73 27   | 9 30  |
| Charn P.             | 70 5    | 22 17 |
| Dangey I.            | 67 23   | 27 19 |
| Herjolfs Nefs        | 65 3    | 30 19 |
| Whales I.            | 62 30   | 39 3  |
| C. Discord           | 60 50   | 39 53 |
| C. Prince Christian  | 59 55   | 41 30 |
| * C. Farewell        | 59 38   | 42 38 |
| C. Desolation        | 62 0    | 46 7  |

*Davis's Straits.*

|                          |         |        |
|--------------------------|---------|--------|
| C. Resolution            | 62 40N. | 46 38W |
| C. Comfort               | 62 45   | 47 30  |
| Hope Harbour             | 63 55   | 47 50  |
| Gilbert's Sound          | 64 15   | 47 53  |
| Cookes Sound             | 64 50   | 47 58  |
| K. Christian's River     | 66 7    | 47 8   |
| Musketto Cove            | 64 55   | 52 51  |
| Romel Fort               | 67 22   | 45 53  |
| Disco I. S. W. Point     | 69 6    | 44 38  |
| Waygate I.               | 70 40   | 44 8   |
| James's I. C. Bedford    | 68 30   | 50 8   |
| Cumberland I. S. P.      | 66 0    | 60 30  |
| Bay of Good Fortune      | 61 20   | 61 29  |
| C. Elizabeth             | 62 5    | 64 30  |
| Resolution I. C. Warwick | 61 4    | 64 30  |

*Hudson's Bay.*

|                  |        |        |
|------------------|--------|--------|
| Button's Isles   | 60 47N | 65 16W |
| Lowe's Savage I. | 61 48  | 66 20  |
| Terra Nieva      | 62 4   | 68 0   |



TABLE XXIV. OF LATITUDES, AND LONGITUDES.

|                      | Lat.<br>D. M. | Long.<br>D. M. |
|----------------------|---------------|----------------|
| Saddle Back I.       | 62 10 N.      | 68 10 W.       |
| Great Bear I.        | 54 4          | 79 56          |
| Ice Cove             | 62 0          | 69 0           |
| Baker's Dozen        | 57 0          |                |
| Great Savage I.      | 62 25         | 70 0           |
| North Bluff          | 62 26         | 71 10          |
| God's Mercies        | 62 28         | 70 48          |
| Salisbury I.         | 63 30         | 76 50          |
| Nottingham, E. End   | 63 35         | 76 45          |
| C. Charles, East End | 62 50         | 74 15          |
| West End             | 62 40         | 76 0           |
| Burgeo Isles         | 47 36         | 57 36          |
| C. Walsingham        | 62 40         | 78 0           |
| C. Diggs             | 62 45         | 78 48          |
| Mansfield, North End | 62 40         | 78 0           |
| South End            | 61 35         | 81 30          |
| Sleepers I.          | 60 10         | 81 30          |
| Great ditto          | 58 35         | 81 30          |
| C. Pembroke          | 62 57         | 82 10          |
| Large Swan's Nest    | 62 20         | 83 30          |
| C. Southampton       | 62 10         | 86 10          |
| Churchill River      | 58 47         | 94 7           |
| Charlton I.          | 52 3          | 79 5           |
| Port Nelson's Shoals | 57 35         | 92 30          |
| Hay River            | 57 10         | 93 0           |

*From Hudson's Bay to Quebec.*

|                         | Lat.<br>D. M. | Long.<br>D. M. |
|-------------------------|---------------|----------------|
| Button's Islands        | 60 47 N.      | 65 16 W.       |
| Black Head              | 59 50         | 63 32          |
| Falke Black Head        | 59 20         | 69 14          |
| Cardinals I.            | 58 50         | 62 55          |
| Steel S.                | 58 7          | 61 45          |
| East I.                 | 57 45         | 61 15          |
| Sadel Islands           | 57 13         | 60 45          |
| Inchanted Cape          | 56 40         | 60 50          |
| St. Peter's Harbour     | 56 28         | 60 45          |
| C. Harrison             | 54 54         | 56 45          |
| Great Bay of Ekimaux    | 54 20         | 57 30          |
| C. Charles              | 52 13         | 55 25          |
| York Point              | 51 57         | 55 52          |
| Red Bay                 | 51 44         | 61 25          |
| Black Bay               | 61 40         | 56 42          |
| Red Cliffs              | 51 33         | 56 45          |
| Forteau Bay             | 51 30         | 56 55          |
| Grand Point             | 51 24         | 57 12          |
| Esquimaux Bay           | 51 28         | 57 45          |
| Haha Bay                | 50 52         | 59 2           |
| Great Mecatina P.       | 50 42         | 59 8           |
| Little Mecatina Islands | 50 28         | 59 27          |
| Mount Joli              | 50 5          | 61 30          |
| Esquimaux Islands       | 50 12         | 63 0           |
| Mingan I.               | 50 16         | 63 15          |
| Grand Bay, St. John's   | 50 22         | 64 0           |
| The Seven Island Bay    | 50 7          | 65 45          |
| Trinity Bay             | 49 37         | 66 27          |
| St. Nicholas's Bay      | 49 28         | 67 0           |
| Laval Bay               | 48 55         | 68 0           |
| Bay of Rocks            | 48 5          | 68 38          |
| St. Paul's Bay          | 47 30         | 69 10          |
| Quebec                  | 46 55         | 69 46          |

*Newfoundland.*

|                                                    | Lat.<br>D. M. | Long.<br>D. M. |
|----------------------------------------------------|---------------|----------------|
| Belle Isle, Var. 20° 30'                           |               |                |
| West                                               | 51 55 N.      | 55 35 W.       |
| Quirpon Harbour                                    | 51 40         | 55 34          |
| St. Anthony's Cape                                 | 51 17         | 55 39          |
| Hare Bay                                           | 51 15         | 55 56          |
| Groais I.                                          | 50 55         | 55 40          |
| Green I.                                           | 50 47         | 55 30          |
| Hooping Harbour                                    | 50 46         | 56 13          |
| White Bay                                          | 50 15         | 56 20          |
| Horle Islands                                      | 50 21         | 56 46          |
| C. St. John                                        | 50 10         | 55 33          |
| Bay of Notre Dame                                  | 50 0          | 55 30          |
| Twillingate Islands                                | 50 3          | 54 35          |
| Fogo I.                                            | 50 0          | 53 49          |
| Gander Bay                                         | 49 40         | 54 10          |
| Wadham Islands                                     | 49 54         | 53 25          |
| C. Freels                                          | 49 34         | 52 55          |
| Funk I.                                            | 50 1          | 54 12          |
| Barrow Harbour                                     | 48 50         | 53 0           |
| C. Bonavista                                       | 48 52         | 52 35          |
| Trinity Bay                                        | 48 30         | 53 0           |
| P. of Grates                                       | 48 22         | 52 30          |
| C. St. Francis                                     | 47 54         | 52 25          |
| * St. John's Harbour                               | 47 32         | 52 20          |
| Great Burgeo I.                                    | 47 36         | 57 30          |
| C. Spear                                           | 47 30         | 52 13          |
| Bay of Bulls                                       | 47 41         | 52 24          |
| C. Broyle                                          | 47 3          | 52 30          |
| C. Ballard                                         | 46 49         | 52 37          |
| C. Race                                            | 46 39         | 52 44          |
| Virgin Rocks                                       | 46 30         | 50 18          |
| C. Pine                                            | 46 40         | 53 15          |
| St. Mary's Bay                                     | 46 50         | 53 30          |
| C. St. Mary's                                      | 46 52         | 54 2           |
| Bay of Placentia                                   | 47 0          | 54 30          |
| Chapeau Rouge                                      | 46 52         | 55 17          |
| St. Peter's I.                                     | 46 36         | 56 6           |
| Langley I.                                         | 46 42         | 56 15          |
| Great Miquelon                                     | 46 55         | 56 16          |
| Burnet                                             | 47 15         | 55 36          |
| Fortune Bay                                        | 47 16         | 55 30          |
| Penguin's Islands                                  | 47 24         | 57 0           |
| Runney I.                                          | 47 32         | 57 25          |
| Great Barrifuay                                    | 47 37         | 57 40          |
| * Burges I.                                        | 47 32         | 57 37          |
| C. Ray, Var. 20° West                              | 47 37         | 59 10          |
| Cod Roy I.                                         | 47 52         | 59 18          |
| C. St. George, Var. 19° W                          | 48 30         | 59 8           |
| South Head                                         | 49 7          | 58 21          |
| C. St. Gregory, Var. 22° 40' West                  | 49 22         | 58 12          |
| Bay St. Paul                                       | 49 50         | 57 50          |
| Ingornachoix Bay                                   | 50 38         | 57 22          |
| St. John's I.                                      | 50 50         | 57 18          |
| Point Ferolle                                      | 57 3          | 57 6           |
| Bay St. Barbe                                      | 51 15         | 56 48          |
| C. Norman                                          | 51 40         | 55 57          |
| Limits of the Great Bank of Newfoundland, North P. | 50 15         | 49 45          |
| South P.                                           | 41 0          | 52 0           |
| Outer Bank                                         | 47 0          | 45 0           |

TABLE XXIV. OF LATITUDES AND LONGITUDES.

*The Gulf of St. Lawrence.*

|                                                         | Lat.<br>D. M. | Long.<br>D. M. |                                          | Lat.<br>D. M. | Long.<br>D. M. |
|---------------------------------------------------------|---------------|----------------|------------------------------------------|---------------|----------------|
| St Paul's I. ———                                        | 47 12 N.      | 59 55 W.       | Charlotte Bay, Var. 14°                  |               |                |
| Bird Islands ———                                        | 47 55         | 60 36          | West ———                                 | 44 34 N.      | 63 50 W.       |
| Brion I. ———                                            | 47 52         | 60 55          | Port Jackson ———                         | 44 13         | 64 22          |
| Magdalen I. N. E. P. ———                                | 47 41         | 60 55          | Isle of Hope ———                         | 43 53         | 64 39          |
| S. W. P. ———                                            | 47 12         | 61 36          | Port Roseway ———                         | 43 40         | 65 12          |
| Entry I. ———                                            | 47 15         | 61 15          | C. Sable, Var. 11° 15'                   |               |                |
| Deadman's I. ———                                        | 47 15         | 61 48          | West ———                                 | 43 27         | 65 30          |
| I. of Anticosta, E. P. ———                              | 49 8          | 61 34          | Seal Isles ———                           | 43 27         | 65 55          |
| S. W. ditto ———                                         | 49 22         | 63 18          | C. Forchu ———                            | 43 54         | 66 4           |
| West ditto ———                                          | 49 48         | 64 18          | St. Mary's Cape, Var. 11° 45' West       | 44 10         | 66 7           |
| North ditto ———                                         | 49 53         | 63 58          | Breyer's I. Var. 11° 15'                 |               |                |
| I. de Bik, in the R. St. Lawrence                       | 48 52         | 67 50          | West ———                                 | 44 19         | 66 20          |
| Mount Camille ———                                       | 48 37         | 67 15          | Anapolis Royal ———                       | 44 47         | 65 43          |
| C. St. Ann ———                                          | 49 3          | 66 0           | Hauto I. ———                             | 45 19         | 64 47          |
| Magdalen R. ———                                         | 49 13         | 65 18          | C. Chignecto, Entrance                   |               |                |
| C. Rozier ———                                           | 48 47         | 63 56          | Bafon of Mines ———                       | 45 44         | 65 44          |
| C. Gaspe and Bay ———                                    | 48 41         | 63 53          | C. Spencer ———                           | 45 17         | 65 50          |
| Flat P. ———                                             | 45 34         | 63 53          | Moccone's I. Entrance                    |               |                |
| I. Bonaventure ———                                      | 48 28         | 63 53          | of St. John's River ———                  | 45 18         | 65 59          |
| C. Despair ———                                          | 48 24         | 64 1           | Wolf I. ———                              | 45 3          | 66 40          |
| Miscou I. Entrance of                                   |               |                | Grand Manan I. South                     |               |                |
| Chaleur Bay ———                                         | 48 0          | 64 16          | Point ———                                | 64 43         | 66 50          |
| P. Escuminac ———                                        | 47 1          | 64 37          | Western Seal Islands                     | 44 37         | 66 47          |
| St. John's I. N. Cape                                   | 47 2          | 63 49          | Machois Bay ———                          | 44 44         | 67 15          |
| West Point ———                                          | 46 34         | 64 11          | Gouldsbrough Harbour                     | 44 34         | 67 56          |
| East ditto ———                                          | 46 27         | 64 48          | Mount Desert Rock ———                    | 44 3          | 67 50          |
| Bear Cape ———                                           | 46 0          | 62 13          | C. Ann Light-House                       | 42 51         | 70 4           |
| Hillsborough Bay ———                                    | 46 6          | 62 55          | Boston Harbour ———                       | 42 25         | 70 31          |
| C. St. George or St. Lewis                              | 45 51         | 61 44          | C. Cod ———                               | 42 5          | 69 40          |
| Gut of Canfor, North                                    |               |                | Cashes Ledge, North P.                   | 43 23         | 69 0           |
| Entrance ———                                            | 45 42         | 61 22          | South P. ———                             | 42 58         | 68 58          |
| Justan Corp I. ———                                      | 45 56         | 61 22          | St. George's Bank, N.                    |               |                |
| Port Hood ———                                           | 45 57         | 61 20          | W. Part ———                              | 41 42         | 68 5           |
| C. North, E. off Cape Breton                            | 47 1          | 60 10          | Nantucket I. ———                         | 41 1          | 69 30          |
| Port Dauphin, ditto                                     | 46 23         | 60 13          | Ditto Shoals, S. W. P.                   | 40 42         | 69 26          |
| Spanish Bay, ditto                                      | 46 18         | 59 57          | Martha's Vineyard I.                     | 41 18         | 70 20          |
| Flint I. ———                                            | 46 11         | 59 33          | Noman's Land I. ———                      | 41 12         | 70 25          |
| Scatari I. ———                                          | 46 2          | 59 27          | Rhode I. Harbour ———                     | 41 2          | 71 0           |
| C. Breton ———                                           | 45 57         | 59 39          | Block I. Middle ———                      | 41 10         | 71 23          |
| Louisburg ———                                           | 45 54         | 59 49          | Montuk Point, Long I.                    | 41 4          | 71 46          |
| C. Hinchinbroke ———                                     | 45 34         | 60 24          | * Sandy Hook ———                         | 40 25         | 74 0           |
| I. Madam ———                                            | 45 29         | 60 44          | * New York Harbour                       | 40 43         | 74 5           |
| Gut of Canfor, South                                    |               |                | * C. May ———                             | 38 58         | 74 52          |
| Entrance ———                                            | 46 28         | 60 46          | * C. Henlopen, Var. 6°                   |               |                |
| Chedabucto Bay ———                                      | 46 23         | 60 46          | West ———                                 | 38 46         | 75 5           |
| <i>From Cape Canfor in Nova-Scotia to Cape Florida.</i> |               |                | Philadelphia ———                         | 39 57         | 75 7           |
| Sable I. East Point                                     | 44 8 N.       | 59 55 W.       | Falfe Cape ———                           | 38 30         | 75 6           |
| West ditto ———                                          | 44 4          | 60 30          | C. Charles ———                           | 37 11         | 75 9           |
| C. Canfor, Var. 15° W.                                  | 45 16         | 60 50          | C. Henry ———                             | 36 57         | 76 4           |
| Port Howe ———                                           | 45 13         | 61 0           | C. Hatteras ———                          | 35 16         | 75 54          |
| Torbay ———                                              | 45 12         | 61 11          | Ditto Shoals, S. W. P.                   | 34 54         | 75 24          |
| Sandwich Bay ———                                        | 45 8          | 61 31          | C. Lookout ———                           | 34 22         | 77 4           |
| Port Stephens ———                                       | 45 0          | 61 53          | Shoals off ditto, S. Point               | 34 10         | 77 0           |
| Hallifax Harbour ———                                    | 44 36         | 63 23          | C. Fear ———                              | 33 51         | 78 28          |
| C. Sambro Light-House                                   | 44 30         | 63 27          | Frying-pan Shoals, off ditto, S. E. Part | 33 30         | 78 17          |
|                                                         |               |                | George Town ———                          | 33 27         | 79 24          |
|                                                         |               |                | Shoals off ditto ———                     | 33 5          | 79 13          |
|                                                         |               |                | C. Roman ———                             | 33 5          | 79 30          |
|                                                         |               |                | Charles-Town Light-House                 | 32 42         | 80 10          |
|                                                         |               |                | Savannah ———                             | 32 3          | 81 24          |
|                                                         |               |                | Tybee Light ———                          | 32 0          | 81 10          |

TABLE XXIV. OF LATITUDES AND LONGITUDES.

|                                                                                                                    | Lat.<br>D. M. | Long.<br>D. M. |                                                                | Lat.<br>D. M. | Long.<br>D. M. |
|--------------------------------------------------------------------------------------------------------------------|---------------|----------------|----------------------------------------------------------------|---------------|----------------|
| Port Royal                                                                                                         | 32 12 N.      | 80 54 W        | Monjes Islands                                                 | 12 23 N.      | 71 21 W        |
| River St. John,                                                                                                    |               |                | C. Coquibacoo                                                  | 12 5          | 71 21          |
| Entrance                                                                                                           | 30 18         | 81 30          | Aruba I. E. Point                                              | 12 9          | 69 25          |
| Augustine Bay                                                                                                      | 29 47         | 81 21          | Curaco I. N. Point                                             | 12 25         | 69 7           |
| C. Caneveral                                                                                                       | 28 20         | 80 45          | C. St. Roman                                                   | 11 30         | 69 30          |
| Shoals off ditto                                                                                                   | 28 20         | 80 40          | * Point Cabello                                                | 10 31         | 67 26          |
| C. Florida                                                                                                         | 25 44         | 80 44          | * Aves I. S. Part                                              | 11 54         | 67 13          |
| I. of Bermudas, Saint                                                                                              |               |                | Roca I.                                                        | 11 45         | 66 17          |
| George's Town                                                                                                      | 32 45         | 63 30          | Orchilla I. S. Part                                            | 11 44         | 66 3           |
| N. W. Point                                                                                                        | 32 25         | 63 25          | Salt Tortuga, E. ditto                                         | 11 0          | 64 44          |
| S. W. Point                                                                                                        | 32 11         | 63 40          | Blanca I. N. ditto                                             | 11 40         | 63 56          |
| NOTE. This Island is surrounded with dangerous Rocks at six or seven Miles distance, especially on the North Side. |               |                | Margarita I. N. E. P.                                          | 11 10         | 63 13          |
| From Cape Florida to Cape Horn.                                                                                    |               |                | N. W. d tto                                                    | 11 3          | 63 46          |
| * C. Florida                                                                                                       | 25 44 N       | 80 44 W        | C. Three Points                                                | 10 19         | 6 25           |
| * Dry Tortugas Shoals,                                                                                             |               |                | Oroonoco River                                                 | 8 25          | 59 26          |
| S. W. Point                                                                                                        | 24 38         | 83 40          | Essequibo River                                                | 6 30          | 58 30          |
| C. Sable                                                                                                           | 24 57         | 81 52          | Surinam River                                                  | 5 52          | 55 2           |
| C. Roman                                                                                                           | 25 42         | 82 36          | * Cayenne                                                      | 4 56          | 52 10          |
| * Charlotte Harbour                                                                                                | 26 43         | 82 24          | C. North                                                       | 1 48          | 49 57          |
| * Spiritu Santo Bay                                                                                                | 27 36         | 82 54          | Mouth of R. Amazon                                             | 0 18          | 51 30          |
| Bay of Apalache                                                                                                    | 29 40         | 85 0           | St. Louis de Maranham                                          | 2 15 S.       | 46 34          |
| C. St. Blaze                                                                                                       | 29 35         | 85 44          | C. Baras                                                       | 3 0           | 42 26          |
| Penfacola Bar                                                                                                      | 30 15         | 87 34          | C. St. Roque                                                   | 5 1           | 36 17          |
| Mobile Point                                                                                                       | 30 11         | 88 35          | Pernambuca or Plende                                           | 8 0           | 35 0           |
| * New Orleans                                                                                                      | 29 58         | 89 53          | C. St. Augustine                                               | 8 32          | 35 0           |
| Mouth of R. Mississippi                                                                                            | 29 13         | 89 27          | St. Francisco River                                            | 11 0          | 36 15          |
| Mouth of Rio Brava                                                                                                 | 26 7          | 90 49          | St. Salvadore                                                  | 12 46         | 38 38          |
| New St. Ander                                                                                                      | 23 46         | 90 27          | Porto Seguro                                                   | 16 36         | 39 30          |
| C. Roxo                                                                                                            | 21 57         | 99 42          | Abrolhos Banks                                                 | 18 0          | 38 30          |
| * Vera Cruz                                                                                                        | 19 12         | 97 24          | Espiritu Santo                                                 | 20 0          | 39 45          |
| Campeche                                                                                                           | 19 41         | 92 54          | C. St. Thome                                                   | 21 51         | 40 20          |
| Praceles Shoals, N. P.                                                                                             | 23 50         | 88 54          | C. Frio                                                        | 22 35         | 41 15          |
| * C. Catoche                                                                                                       | 21 38         | 87 26          | * Rio Janeiro                                                  | 22 54         | 42 38          |
| * Loggerhead Key                                                                                                   | 21 38         | 87 14          | Grande I.                                                      | 23 15         | 43 30          |
| Falfe C.                                                                                                           | 21 28         | 87 14          | Santos                                                         | 24 4          | 45 30          |
| Cozumel I. S. Point                                                                                                | 20 3          | 87 34          | St. Catherine's I.                                             | 27 15         | 49 0           |
| North Triangles, S. P.                                                                                             | 18 25         | 87 26          | Porto St. Pedro                                                | 31 44         | 55 17          |
| N. Point                                                                                                           | 19 5          | 87 27          | * C. St. Mary, North                                           |               |                |
| Key Bokel                                                                                                          | 16 27         | 88 14          | Entrance to R. Plate                                           | 34 45         | 54 10          |
| Glovers Reef, N. Part                                                                                              | 16 52         | 87 47          | * C. St. Anthony, S.                                           |               |                |
| S. ditto                                                                                                           | 16 33         | 88 17          | Entrance to ditto                                              | 36 31         | 58 27          |
| Utilo, E. Point                                                                                                    | 16 11         | 87 27          | * Buenos Ayres in ditto                                        |               |                |
| Ratran I. E. Point                                                                                                 | 16 25         | 86 30          | River                                                          | 34 35         | 58 25          |
| Bonacca I. N. E. ditto                                                                                             | 16 29         | 85 55          | C. La Matas                                                    | 45 0          | 65 45          |
| C. Honduras                                                                                                        | 16 1          | 86 9           | * C. Blanco                                                    | 47 20         | 64 36          |
| C. Cameron                                                                                                         | 16 0          | 85 9           | Bay St. Julian                                                 | 49 10         | 68 38          |
| Black River                                                                                                        | 15 56         | 85 4           | Straits of Magellan                                            | 52 35         | 67 45          |
| C. Dias Gracias                                                                                                    | 15 1          | 82 50          | * C. Success                                                   | 55 1          | 65 21          |
| Triangles, S. Part                                                                                                 | 16 30         | 79 55          | C. St. Diego                                                   | 54 34         | 65 15          |
| N. ditto                                                                                                           | 17 0          | 80 53          | C. St. Anthony                                                 | 54 47         | 64 53          |
| Sand Key, N. Part                                                                                                  | 16 30         | 78 20          | C. St. Bartholomew                                             | 54 58         | 64 51          |
| St. Andrew's I.                                                                                                    | 12 32         | 80 50          | C. St. John                                                    | 54 47         | 63 51          |
| Corn Islands, N. Part                                                                                              | 12 10         | 82 2           | * C. Horn                                                      | 55 58         | 67 20          |
| St. John's Point                                                                                                   | 10 33         | 82 50          | The West Coast of America from Cape Horn to Behring's Straits. |               |                |
| * Porto Bello                                                                                                      | 9 33          | 79 44          | * Cape Horn                                                    | 55 58 S.      | 67 20 W        |
| Gulf of Darien                                                                                                     | 8 40          | 76 40          | * Barnwell's I.                                                | 55 49         | 66 52          |
| * Carthagena                                                                                                       | 10 27         | 75 21          | * C. Diego                                                     | 54 33         | 64 6           |
| * St. Martha                                                                                                       | 11 27         | 73 59          | * Juan Fernandez I.                                            | 33 36         | 71 22          |
| C. de la Vala                                                                                                      | 12 10         | 71 53          | * Arica                                                        | 18 29         | 71 5           |
|                                                                                                                    |               |                | * Concepcion Bay                                               | 35 43         | 72 34          |



TABLE XXIV. OF LATITUDES AND LONGITUDES.

|                                    | Lat.<br>D. M. | Long.<br>D. M. |                        | Lat.<br>D. M. | Long.<br>D. M. |
|------------------------------------|---------------|----------------|------------------------|---------------|----------------|
| Lima                               | 12 15         | 76 43W         | St. Eustatia, the Town | 17 29N        | 63 4W          |
| Galapagos Isles                    | 23 30N        | 85 0           | Saba                   | 17 39         | 63 8           |
| Panama                             | 8 48          | 80 15          | Aves I.                | 15 33         | 63 35          |
| Acapulco                           | 17 10         | 101 40         | Barbuda, S. E. Point   | 17 50         | 61 45          |
| Corrientes                         | 22 20         | 107 0          | St. Bartholomew, E. P. | 17 56         | 62 34          |
| California, South Point            | 23 30         | 109 30         | W. ditto               | 17 54         | 62 51          |
| de Touche                          | 45 24         | 125 5          | St. Martin's, E. Point | 18 3          | 62 50          |
| Fitzhugh                           | 51 0          | 128 57         | W. ditto               | 18 40         | 63 7           |
| St. James                          | 52 0          | 131 34         | Anguilla, N. E. Point  | 18 22         | 62 46          |
| Caldwell                           | 54 18         | 133 33         | S. W. ditto            | 18 9          | 63 5           |
| Edgecumbe                          | 57 3          | 135 47         | Prickly Pear           | 18 20         | 63 10          |
| Nootka, or Saint                   |               |                | Sambero                | 18 26         | 63 21          |
| George's Sound                     | 49 36         | 126 42         | Anegado, E. Point      | 18 36         | 63 50          |
| Pr. William's Sound                | 61 5          | 147 15         | W. ditto               | 18 41         | 64 1           |
| Cook's River                       | 59 0          | 152 0          | St. Croix, E. Point    | 17 36         | 63 40          |
| Grevill                            | 57 30         | 153 0          | W. ditto               | 17 44         | 64 25          |
| Alaska, S. Point                   | 54 45         | 163 11         | Virgin Gorda, E. Point | 18 18         | 63 40          |
| Shallow-Water P.                   | 63 0          | 162 45         | The Fort               | 18 18         | 63 54          |
| Stephens                           | 64 21         | 162 15         | Tortola, E. Point      | 18 21         | 64 27          |
| Norton Sound                       | 64 15         | 162 0          | W. ditto               | 18 18         | 64 39          |
| C. Rodney                          | 64 35         | 164 24         | St. John's, S. Point   | 18 5          | 64 40          |
| C. Prince of Wales                 | 65 45         | 168 13         | St. Thomas, S. ditto   | 18 25         | 64 41          |
| <i>Islands in the West Indies.</i> |               |                | The Town               | 18 22         | 64 46          |
| Trinidad, N. E. P.                 | 0 45N         | 60 36W         | Porto Rico, N. E. Pt.  | 18 39         | 65 39          |
| Trinidad, N. E. ditto              | 11 29         | 59 57          | S. E. ditto            | 18 10         | 65 38          |
| S. W. ditto                        | 11 5          | 60 49          | N. W. ditto            | 18 41         | 67 46          |
| Grenada, N. E. P.                  | 12 14         | 61 49          | S. W. ditto            | 18 11         | 67 45          |
| S. W. ditto                        | 11 57         | 62 19          | La Mona I.             | 18 10         | 68 24          |
| Grenada Bank, Middle               | 11 55         | 62 45          | Hispaniola, or         |               |                |
| Barbadoes, S. Point                | 13 7          | 59 45          | St. Domingo            |               |                |
| E. ditto                           | 13 12         | 59 37          | Cape Enganno           | 18 27         | 68 35          |
| Bridge Town                        | 13 9          | 59 51          | Soona I. E. Point      | 17 55         | 68 48          |
| N. W. Point                        | 13 22         | 59 52          | * Altavila Rock,       |               |                |
| Vincent, N. Point                  | 13 12         | 61 16          | off ditto              | 17 28         | 71 35          |
| S. ditto                           | 13 4          | 61 15          | Abacou Point           | 18 2          | 73 48          |
| Lucia, S. Point                    | 13 30         | 61 0           | * Porto Prince         | 18 40         | 72 10          |
| N. ditto                           | 13 56         | 60 46          | C. Tiberon             | 18 20         | 74 31          |
| Martinico, S. E. Point             | 14 24         | 60 57          | * Fort St. Louis       | 18 19         | 73 15          |
| Diamond ditto                      | 14 24         | 61 1           | Nayaza I.              | 18 24         | 74 59          |
| Port Royal                         | 14 36         | 61 4           | C. Dona Maria          | 18 38         | 74 22          |
| W. Point                           | 14 25         | 61 14          | * Petit Grove          | 18 27         | 72 49          |
| N. E. ditto                        | 14 58         | 61 0           | C. Nicolas             | 19 50         | 73 25          |
| Dominica, S. Point                 | 15 15         | 61 20          | * The Mole             | 19 49         | 73 25          |
| N. ditto                           | 15 29         | 61 25          | Tortudos, E. Point     | 20 2          | 73 32          |
| Marigalante, N. E. P.              | 16 4          | 61 0           | W. ditto               | 20 5          | 72 56          |
| S. E. ditto                        | 15 53         | 60 59          | Monte Christo          | 19 56         | 71 39          |
| Guadaloupe, S. Point               | 15 54         | 61 43          | * Old C. Francois      | 19 40         | 69 57          |
| N. ditto                           | 16 30         | 61 42          | * C. Samana            | 19 15         | 69 10          |
| Guadeterre, S. E. P.               | 16 15         | 61 4           | C. Raphael             | 18 56         | 69 0           |
| N. ditto                           | 16 41         | 61 25          | Island of Jamaica      |               |                |
| Neerada, N. E. Point               | 16 24         | 60 56          | Morant P. E. End       | 17 58         | 76 10          |
| S. W. ditto                        | 16 18         | 61 3           | * Port Royal           | 18 0          | 76 48          |
| Antigua, E. Point                  | 17 3          | 61 45          | Portland Point         | 17 42         | 77 2           |
| Montserrat, N. E. P.               | 16 47         | 62 12          | Carlisle Bay           | 17 50         | 77 15          |
| S. W. ditto                        | 16 40         | 62 15          | Pedro Bluffs           | 17 52         | 77 35          |
| Redondo I.                         | 17 3          | 62 20          | Black River            | 18 5          | 77 40          |
| St. Christopher's, S. P.           | 17 17         | 62 28          | Savannah la Mar        | 18 15         | 78 6           |
| Point                              | 17 16         | 62 31          | Negril Point           | 18 17         | 78 31          |
| N. W. ditto                        | 17 26         | 62 42          | Montego Bay            | 18 33         | 77 52          |
|                                    |               |                | St. Ann's Harbour      | 18 39         | 76 56          |
|                                    |               |                | Porta Maria            | 18 32         | 76 35          |
|                                    |               |                | Port Anthony           | 18 25         | 76 5           |

TABLE XXIV. OF LATITUDES AND LONGITUDES.

|                                                 | Lat.<br>D. M. | Long.<br>D. M. |                                       | Lat.<br>D. M. | Long.<br>D. M. |
|-------------------------------------------------|---------------|----------------|---------------------------------------|---------------|----------------|
| Islands and Shoals lying<br>off Jamaica         |               |                | Heneaga, N. E. Point                  | 21 20N.       | 72 59W         |
| Morant Keys, N. E. P.                           | 17 26N.       | 75 55W         | W. ditto                              | 21 0          | 73 40          |
| S. W. ditto                                     | 17 24         | 75 48          | Little Heneaga, W. P.                 | 21 30         | 73 8           |
| Formogas                                        | 18 31         | 75 39          | N. ditto                              | 21 34         | 73 0           |
| Pedro Shoals, E. P.                             | 17 20         | 77 1           | Hogfye's, the Middle                  | 21 41         | 73 50          |
| Little Cayman, S.                               |               |                | Mayaguana, S. Point                   | 22 20         | 72 33          |
| W. ditto                                        | 19 32         | 80 10          | N. ditto                              | 22 29         | 72 53          |
| Great Cayman, S.                                |               |                | S. W. ditto                           | 22 22         | 72 55          |
| W. ditto                                        | 19 11         | 81 8           | French Keys                           | 22 42         | 73 27          |
| N. ditto                                        | 19 18         |                | Miraperoos Keys, S. P.                | 22 7          | 74 18          |
| Swan I. S. W. ditto                             | 17 12         | 83 30          | Castle I. or South Key                | 22 8          | 74 0           |
| Mesteriosa Shoal                                | 18 0          | 83 50          | North Key, Crooked I.                 | 22 49         | 74 2           |
| A dry Bank                                      | 18 36         | 73 15          | Atwood's Key, N. E. P.                | 23 13         | 73 25          |
| Pracel Shoal                                    | 18 50         | 84 20          | Key Verde, S. W. ditto                | 22 12         | 75 10          |
| Island of Cuba                                  |               |                | The Brothers                          | 22 38         | 75 0           |
| C. Mayze                                        | 20 16         | 74 4           | Long I. S. E. Point                   | 22 50         | 74 45          |
| S. Jago                                         | 20 12         | 75 35          | N. ditto                              | 23 30         | 75 28          |
| Cumberland Har-<br>bour                         | 19 53         | 75 13          | Rum Key                               | 23 33         | 74 57          |
| Cabo de Cruz                                    | 19 42         | 77 32          | Watlands I. S. Part                   | 23 57         | 74 35          |
| I. of Pines S. W.<br>Point                      | 21 20         | 83 12          | Little I. its Centre                  | 24 4          | 74 30          |
| C. Corientes                                    | 21 46         | 84 57          | Cat I. S. Part                        | 24 4          | 74 44          |
| Middle Cape                                     | 21 44         | 84 34          | N. ditto                              | 24 39         | 75 12          |
| Cape Antonio                                    | 21 49         | 85 15          | Exuma, E. ditto                       | 23 34         | 75 10          |
| Colorados Rocks,<br>N. W. P.                    | 22 30         | 85 14          | Eleuthera, Powell's Pt.<br>or S. Part | 24 45         | 76 10          |
| Havannah                                        | 23 12         | 82 12          | Egg I. or W. Part                     | 25 35         | 77 10          |
| Matanzas                                        | 23 12         | 81 15          | New Providence, W. P.                 | 21 56         | 78 5           |
| Islands and Shoals North<br>of Cuba and Jamaica |               |                | * Nassau Town in ditto                | 25 4          | 77 45          |
| Last Reef                                       | 20 12         | 68 43          | W. P. of ditto                        | 24 57         | 78 3           |
| North Reef S. E. Point                          | 20 15         | 69 29          | Andros I. S. Point                    | 24 5          | 78 0           |
| W. ditto                                        | 20 31         | 70 1           | N. Point                              | 25 15         | 78 30          |
| The Triangle                                    | 20 40         | 69 48          | Frozen Key                            | 25 22         | 78 0           |
| Square Handkerchief,<br>N. E. Point             | 21 17         | 70 20          | The Hole in the Wall                  | 26 10         | 77 40          |
| S. W. ditto                                     | 20 53         | 70 57          | Little Bank of Bahama,<br>N. W. Point | 27 45         | 79 44          |
| Grand Turk's I. N. E.<br>ditto                  | 21 32         | 71 5           | Sandy Key                             | 26 33         | 79 34          |
| Sand Key                                        | 21 11         | 71 10          | Great Isaac                           | 26 0          | 79 47          |
| The Great Cayes, S. P.                          | 21 8          | 71 45          | Little ditto                          | 26 5          | 79 11          |
| E. ditto                                        | 21 43         | 71 26          | Cat Keys Harbour                      | 25 10         | 79 36          |
| N. W. ditto                                     | 21 57         | 72 6           | Orange Key                            | 24 43         | 79 36          |
|                                                 |               |                | Double-headed Shot<br>Keys, W. Point  | 24 0          | 80 10          |
|                                                 |               |                | Key Sal                               | 23 31         | 80 3           |
|                                                 |               |                | Anguilla, E. Part                     | 23 22         | 78 43          |

Though this Table is more extensive and nearer the Truth than any published, it being deduced from many thousand Observations, and these compared with the best Sea Charts extant, yet in the Nature of Things it neither now is, nor never can be absolutely correct. For, let two Observers be on board the same Ship with different Instruments they will frequently not agree in their Observations; add to this, that many Observers make no Allowance for the Dip, Refraction, and Difference of the Meridians, respecting the Sun's Declination.

Mr. Dalrymple observed to me, that although he had the inspecting of the Journals of the Officers in the East India Company's Service, yet there were but few Places whose Longitude he could determine with any Degree of Precision.

*EXTRACTS from a Letter written to JAMES BOGLE FRENCH, Esq.  
Foreman of the Special Jury who tried the Cause in the King's Bench  
at Guildhall, between Messrs. SAYER and BENNET, Plaintiffs, and  
Mr. JOHN HAMILTON MOORE, Defendant, by Mr. JOHN  
STEVENSON, one of Mr. MOORE's Witnesses.*

THE Action was brought for copying of certain Charts, the property of the Plaintiffs: and the damages were laid at Ten Thousand Pounds, Mr. Stevenson's Letter was written in consequence of a paragraph in the Public Ledger of March 12, 1785, and a copy of it was published in that paper on the 28th of the same month.

"Upon my being asked by Counsellor Cooper whether I had seen Mr. Sayer's Charts, and those of Mr. Moore's, which were said to be copied from them? I answered in the affirmative, adding that I had not only seen, but carefully examined them. Being then asked, whether I thought Mr. Moore's Charts were exact copies of Mr. Sayer's? I answered, 'No; I think they are essentially different.' Being desired to give the Court an account of that difference, I answer'd in substance as follows: That the Charts of Newfoundland, and the adjacent Coasts, four in number, (three particular and one general) were constructed upon very different principles: Mr. Moore's were constructed upon the true principles of Mercator-sailing; but Mr. Sayer's were neither plain nor Mercator's Charts: they were contrary to every received principle of geography and navigation, and, consequently erroneous. That although the taking of the latitudes and longitudes of the principal places from the same authorities, had occasioned their positive situation to be nearly alike in both sets: yet Mr. Sayer's charts, being constructed upon erroneous principles, the relative situation of places partook of that error, and consequently the course and distance from place to place, were erroneous.

"That the Charts of the Gulf of Florida and the West Indies, were on both sides on the Mercator's projection, but that Mr. Moore's differed materially from Mr. Sayer's in the situation of the principle places; that I found no less than twenty four of those places to differ either from ten to eighteen miles in latitude, or from ten to thirty-three miles in longitude.

"Admiral Campbell, F. R. S. and Governor of Newfoundland, declared to the Court, that Mr. Moore's Charts, so far from being considered in the light of exact copies, were really a very meritorious and happy improvement on charts, (Mr. Sayer's) which he reprobated as erroneous and dangerous, to such a degree, that when he first examined them, on his station at Newfoundland, he was grieved for the honour of his country, that such a publication should originate in England, and often wished to have had the power of suppressing it intirely by burning all the charts, and destroying the plates.

"Mr. Wales, F. R. S. and Mathematical Master of Christ's Hospital (who circumnavigated as astronomer with Captain Cook) confirmed what had been said by Admiral Campbell, and Mr. Stevenson concerning Mr. Sayer's Charts of Newfoundland and the adjacent Coasts; namely, that they were neither upon the plain, nor Mercator projection, and, consequently, erroneous. With respect to the West Indies, he found that Mr. Moore's Charts differed materially from Mr. Sayer's in the latitudes and longitudes of some principal places.

"The late Lord Mansfield, on summing up the evidence, observed, that the act of the 17th of his present Majesty was made to guard the property of ingenious men against copying, with only some colourable alterations; but never was intended to prevent the making of useful and important improvements. He stated what was said of the four Charts of Newfoundland, and the adjacent Coasts; and with respect to the West Indies, he related what had been said concerning the latitudes and longitudes of twenty-four of the principal places in that quarter. His Lordship also observed, that the situation of places was certainly an important object in the constructing of Charts: and he enforced his observations by saying, that whether the Isle of Wight was exhibited in Charts, where it really stands, or placed in the middle of the British Channel was certainly a matter of great importance to every interested navigator."

The Jury gave a Verdict for Mr. Moore.



*Extract from the Sunday Gazette of the 8th of March, 1789.*

“ON Wednesday last a cause was tried, before Lord Kenyon and a Special Jury of London Merchants, between Mr. David Steel, Bookseller, Union-row, Tower-hill, Plaintiff, and Mr. John Hamilton Moore, Teacher of Navigation, on Tower-hill, Defendant.—The action was to recover £. 3000 damages, alledged by the Plaintiff to have been sustained by him on account of the Defendant having published ‘A Chart of the East Coast of England, including the Navigation from the South Fore-land to Flamborough Head,’ from the ‘latest Observations and Surveys,’ which Mr. Steel contended to have been pirated from two charts of his, published by him in 1782, drawn by John Chandler; when it appeared by the evidence of Mr. John Stevenson, and Mr. Porteus, pilot to the squadron in the North Sea, during the last war, that there are a great many very material errors in Mr. Steele’s Charts, which are corrected in Mr. Moore’s.—Mr. Stevenson pointed out one hundred and six places, in which Mr. Moore’s differed materially from Mr. Steele’s, besides many others of less note.—The Jury were prepared to give a verdict in favour of Mr. Moore, but were prevented by Mr. Steel’s Counsel submitting to a nonsuit, which subjects Mr. Steel to pay Mr. Moore his costs of suit.—Lord Kenyon declared he heartily concurred with the Jury, and expressed his indignation that such erroneous charts as Mr. Steel’s should be published. Mr. Moore was prepared, had it been necessary, with three other masters of the Royal yachts, besides many experienced navigators, to prove the correctness of his Chart, and the erroneousness of Mr. Steele’s.”

Mr. Stevenson observed, that the Isle of Grain in Mr. Steele’s Chart was placed almost its whole breadth too far back from the entrance of the Thames: and that in his particular Draft of the Thames, which was on a larger scale, and therefore admitted of greater accuracy, there did not appear to be any island at all. That the latter appeared to be an exact copy of Mr. Diston’s Draft of the Thames, excepting that the lower part of the river was somewhat more lengthened, which might have been owing to the stretching of the paper in tracing, from the upper part downwards.

When Mr. Stevenson was prevented by the Plaintiff’s Counsel from mentioning all the 106 places in which Mr. Moore’s Charts differed materially from Mr. Steele’s, he proposed to enumerate 13 only, which differed either from 3 to 7½ points in bearing, or from 4 to 9 miles in distance, but was again prevented; he then proposed to speak of one place only, but even in that he was also prevented! the place meant by Mr. Stevenson was the Mouse and West Barrow Sands, which were afterwards adverted to by Mr. Porteus, Mr. Chandler (who drew the Plaintiff’s Charts) instead of making the Buoy on the Shivering-Sand, that on the east end of the Oaze, and the Buoy of the west end of the Mouse, lie nearly in a line with each other in his Chart, has placed the Mouse and the West Barrow Sands above 4 miles farther to the westward than they ought to have been, he has also thought fit to make the Shoe-Beacon follow the Mouse to the westward. The consequences are, instead of the buoy on the Mouse lying 2 miles N. N. W. from the east buoy of the Oaze, he makes it to bear W. ½ N. distance 5 miles, and, instead of laying the Mouse buoy 7 miles E. N. E. from the West buoy of the Oaze, and 5 miles E. by S. ½ S. from the Black Tail Beacon, he makes it to lie 2½ miles N. E. ¼ E. from the former, and 2 miles E. by S. ¾ S. from the latter. Instead of the Shoe-Beacon bearing N. by E. from ships when in the Fairway, between the Nob and the Oaze buoys, Mr. Chandler has placed the Beacon so far to the westward, as to make it bear N. W. and instead of the buoy on the Mouse being seen from ships in the aforesaid situation, bearing N. W. by N. Mr. Chandler, by placing the west end of the West Barrow in that line of bearing, has directed them to look no less than 4½ points more to the westward for the buoy on the Mouse! Mr. Chandler dedicates his Chart, by permission to the Elder Brethren of the Trinity House; but the misplacing of the Oaze-sand is so glaring, that those Elder Brethren, who are so well acquainted with the Nob Channel, must have discovered it at first view; and, if they granted permission without examination, they may be deemed, if possible, more highly culpable. The most rational supposition, is, that Mr. Chandler has laboured under something, which, to say the least, appears very like a mistake!

Mr. Stevenson desired Mr. Champion, one of the Jury, to compare the northernmost part of the Plaintiff’s first Chart, with the southernmost part of his second Chart, and he would see a very considerable difference in the form and situation of those sands which are exhibited in both: which difference, Mr. Stevenson said, amounted to a clear proof, that both Charts had been copied, and copied from different authorities. In the small space which is comprehended in both Charts, the relative positions of no less than 13 places in the second Chart differ from those of the same places in the first Chart, from ½ to 4½ points of the compass.

# A CATALOGUE

## NEW CHARTS, PILOTS, and SEA BOOKS, Published by JOHN HAMILTON MOORE,

*Hydrographer to His Royal Highness the Duke of Clarence,  
And Chartfeller to Her Serene Highness the Empress of Russia.*

And sold by the following Persons : WILLIAM HEATHER, at the NAVIGATION WAREHOUSE, No. 157, *Leadenball-Street, London*; Miller, *Gravesend*; Burgess, *Ramsgate*; Marshall and Wittingham, *Lynn*; Downes and March, *Yarmouth*; Brown, Ferraby, Rawson and Co. *Hull*; Reed, *Sunderland*; Akenhead, *Newcastle*; Kelly, Roddam and Saunders, *North-Shields*; Smart, *South-Shields*; Robertson and Berry, *Edinburgh*; Coke, *Leith*; Millar, *Dunbar*; Watson and Youle, *Greenock*; Dilston and Son, *Elfnear*; Smith, *Liverpool*; Corkhill, *Whitehaven*; Parsons, Hodges, Rowland and Browne, *Bristol*; King and Jackson, *Dartmouth*; Elliot, *Falmouth*; Haydon and Son, *Plymouth*; Wilmot, *Pembroke*; Mottley, Donaldson, and Harding, *Portsmouth*; Watts and Harding, *Gosport*; Moore and Ledgard, *Poole*; M<sup>r</sup>Auley and Hughes, *Dublin*; Owen, *Waterford*; Fitton, *Cork*; John and James Thoreau, *Jersey*; Chevalier, *Guernsey*; Ismay, *Dover*; Sharp and Long, *Deal*.

## CHARTS OF ENGLAND, IRELAND, AND SCOTLAND.

|                                                                                                                                                                                                                         |       |          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------|
| THE British Channel, including that of Bristol and the South-west Coast of Ireland, as far as the river Shannon, constructed upon the true principles of Mercator's Sailing, with a printed Book of Directions          | 0 7 6 | f. s. d. |
| The Mouth of the Thames, shewing the Sands, Buoys, Soundings, &c. from the Nore to the South Foreland and Orfordness, with Part of the River Thames                                                                     | 0 2 6 |          |
| The East-Coasts of England and Scotland, from the South Foreland and London to Aberdeen, and from Bristol to Glasgow, containing St. George's Channel, the whole of Ireland and part of the Western Islands of Scotland | 0 3 0 |          |
| The English Channel from Dungeness to Hartland Point, and the Coast of France from Calais to Bourdeaux, in the Bay of Biscay, including Guernsey, and the Scilly Islands                                                | 0 3 0 |          |
| The East Coast of England, from the South Foreland to Flamborough Head, and River Thames to London, on a Scale of twenty-four Inches to a Degree, with a printed Book of Directions                                     | 0 7 6 |          |
| The Coasts of England and Scotland, from Yarmouth Roads to Duncansby Head and Cape Wrath, including the Orkney Islands, with a printed Book of Directions                                                               | 0 7 6 |          |
| The Orkney Islands, upon a very large Scale                                                                                                                                                                             | 0 5 0 |          |
| The West Coast and Islands of Scotland, from Cape Wrath to the Mull of Cantire, and Part of Ireland                                                                                                                     | 0 7 6 | St.      |

## CHARTS, &c.

|                                                                                                                                                                                                                                                                                                                                  |                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| St. George's and Bristol Channels, from the Mull of Cantire to Hartland Point, and from Rachlin Island to the Tusker, being a Reduction of Mr. Mackenzie's Surveys to a Mercator's Projection, shewing the Times of High-water, and the Rise of Spring and Neap Tides at the principal Harbours, with their different Velocities | £. s. d.<br>0 7 6 |
| The North-west Coast of Ireland, from Belfast to Sligo Bay                                                                                                                                                                                                                                                                       | 0 2 6             |
| The West Coast of Ireland, from Sligo Bay to the River Shannon                                                                                                                                                                                                                                                                   | 0 2 6             |
| The Coast of Ireland, from the River Shannon to Caldy Island                                                                                                                                                                                                                                                                     | 0 5 0             |
| The Coast of Ireland, from Tramore Bay to Dublin and Lambay Bay, upon a very large Scale                                                                                                                                                                                                                                         | 0 5 0             |
| The Coast of Wales, from great Orms Head to Swansea Bay, including the Isle of Anglesea, upon a very large Scale                                                                                                                                                                                                                 | 0 5 0             |
| A compleat Irish Coasting Pilot, from the latest Surveys and Observations                                                                                                                                                                                                                                                        | 0 15 0            |
| Dartmouth Harbour, being an actual Survey made by J. Deffiou                                                                                                                                                                                                                                                                     | 0 3 0             |
| The Isle of Wight, Spithead, and Portsmouth, shewing all the Shoals, Sands, Light-houses, Beacons, Buoys, Sea-marks, Soundings, Anchorage, &c.                                                                                                                                                                                   | 0 5 0             |
| The Downs and Margate Roads, upon a large Scale                                                                                                                                                                                                                                                                                  | 0 2 6             |
| A Delineation of Europe, shewing the Bearings and Distances of the principal Cities from London, with their relative Bearings and Distances                                                                                                                                                                                      | 0 1 0             |

## THE NORTHERN NAVIGATION.

|                                                                                                                                                                                                                                   |        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
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